

INTERFACE AGE™

COMPUTING FOR HOME AND BUSINESS APPLICATIONS

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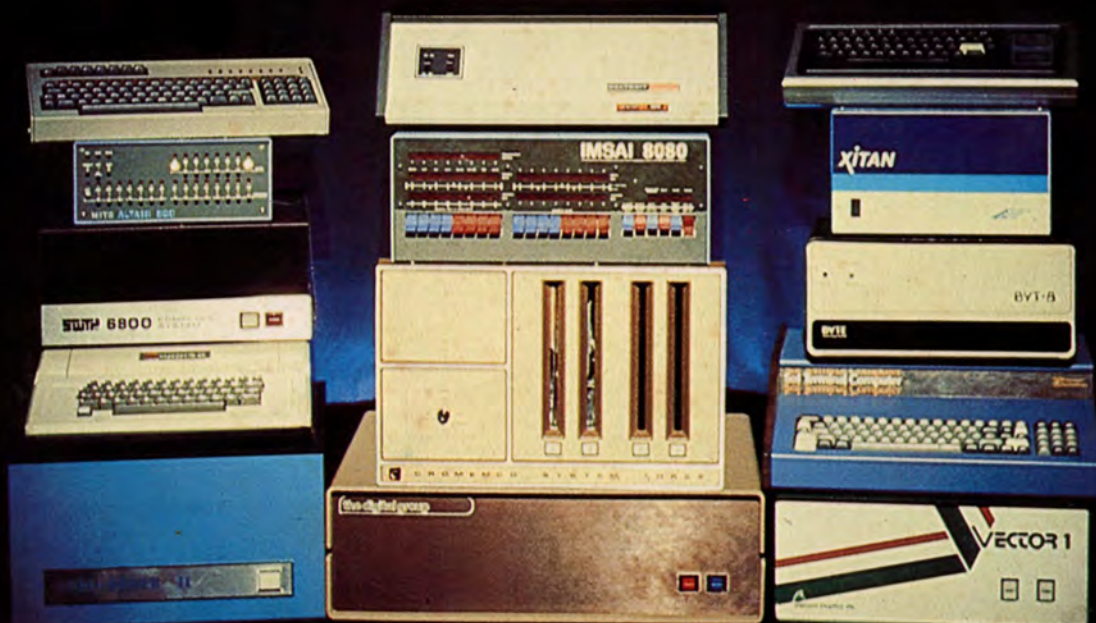


**MEDICAL
APPLICATIONS**

**PREDICTING
HEART ATTACKS**

**INTERFACING A
MICROCOMPUTER TO
THE ANALOG WORLD**

INSIDE ASCII PART III



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THIS MONTH'S COVER

A patient lies in the antiseptic whiteness of a major hospital. Quiet surrounds the room but the patient is not alone. He is being monitored by a small computer on the side of the bed. Any change in the vital body functions will cause the computer to quickly analyze the situation and take the necessary actions.

The actions may be to signal the nurse that a major change has occurred or adjust the setting of a life support system.

This month's cover represents the use of the microcomputer as a physician's tool. Serving as an ever present monitor to critically ill patients or helping in the diagnosis and treatment of disease.

The cover was designed by our Art Director Fino Ortiz; photography by Dick Prochaska. Equipment was supplied by the following Southern California Computer Stores: Advanced Computer Products, Santa Ana; Adventures in Computing, Fountain Valley; Bits N Bytes, Fullerton; and Byte Shop, Placentia.

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INTERFACE AGE™

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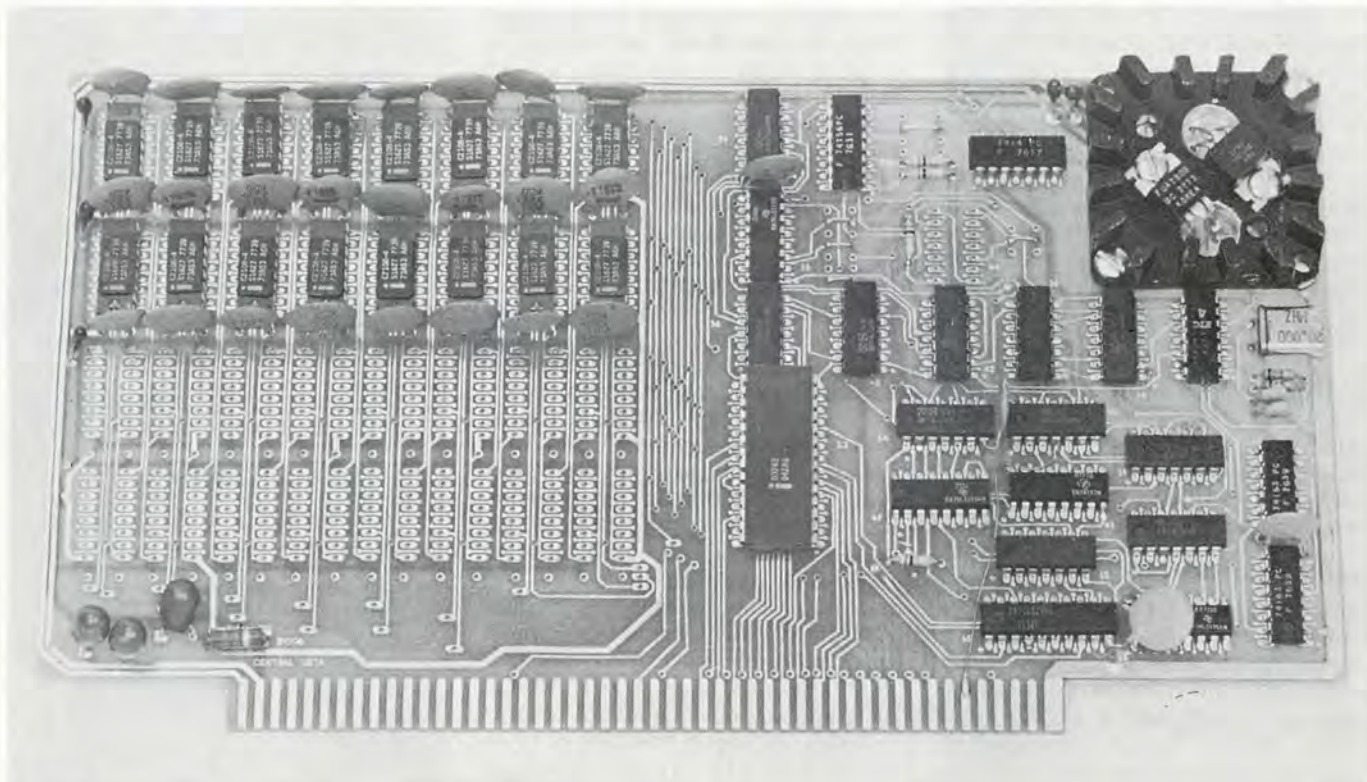
by Bert Johnson

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EDITOR'S NOTEBOOK

I have a lot to talk about this month, but before I get into it, all of us at INTERFACE AGE would like to congratulate Burchanel Green at Creative Computing. Burchie will become a mommy sometime in November and we think it's great.

Many events have taken place in the last several months that have disturbed me, and I think they have done harm to the industry. I am speaking specifically of the number of shows that have and will be taking place this year.

There are over 24 shows. Each time a show is run, the attendance is a little less, the booths a little more shoddy and the attendees' interest level down. As John Dilks put it, "There doesn't seem to be any more excitement."

There are several factors causing this low interest phenomenon, as I see it. The first and most obvious is that there are too many shows. It seems like every month there is at least one show going on somewhere, and promoters are planning even more. Another factor, expressed by my wife, is that people are more concerned about the cost of lettuce than spending ten or twenty dollars to attend a show. The other fact, and probably the most interesting, is that we are now what we wanted to be — an industry, and as such are taken for granted. Practically every magazine you pick up has some story on micros. Even department stores are carrying them as part of their everyday product line. Apparently the industry has really come of age and consequently must review the total situation.

As I see it, there is really only one way to bring back some of the excitement and raise the attendance of the shows. That is to first limit the number of shows to three a year. I would recommend the West Coast Computer Faire begin sometime at the start of the year with alternating sites along the west coast. Next, NCC and Mini-Micro should combine into one large show and either hold it in Chicago or Dallas about mid-year. Of course, Personal Computing should remain to wrap up the year on the east coast.

Along with limiting the number of shows, the gate fee should also be reduced to some reasonable price, say two to three dollars but not more than five. The show should be supported by the exhibitors, not the at-

tendees. The practice of tradeouts should be completely stopped and definite rules should be laid out on what a booth should look like and how the exhibition hall will be set up.

Promoters of shows should be willing, under these conditions, to provide items such as chairs, lounges and moving equipment as part of the total show package to the exhibitor. The promoter should be willing to provide stipend payments to speakers if seminars are to be part of the show, or be willing to provide a percentage of the profits from the sale of seminar tapes or printed proceedings.

This all sounds like I am saying that a committee should be set up to establish all these guidelines. Not really. I do feel that all the show promoters should get together at one place this year, say in August at PCC, and work out a loosely-knit coalition. The industry is mature enough to allow for this to be somewhat self-policing. I don't feel that the magazines, such as INTERFACE AGE, should or even could be responsible for setting up this type of trade watch. What I feel we can do and are obligated to do is provide a forum for the show promoters, attendees and exhibitors to express their feeling on what should be done. Therefore, I invite your input, but please define your place in the industry.

One really excellent thing that does come out of shows is getting a chance to see some pretty interesting pieces of equipment, or getting to talk to people who have become involved in providing some form of service.

At a recent show I had the chance to see a little project put together by INFO 2000. They have taken the Heath H-8, replaced the 8080 CPU with a Z-80 and disk controller and can run CP/M, Microsoft BASIC, CBASIC, FORTRAN and COBOL. They also let me in on a little secret. The Godbout 12K boards for the H-8 are really excellent and provide a cost effective means of adding memory.

Since I am a software type, I really get excited over seeing interesting applications. The Structured Systems Group is what I consider a really top software company. They provide business software — general ledger, name and address lists, and now accounts receivable—that is well thought out, documented and tested. Two other companies, Software Dynamics and Technical Sys-

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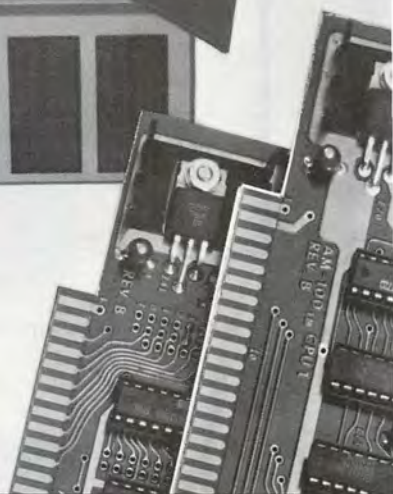
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a business user can have his accounts receivable and other bookkeeping functions running while others are making inventory and sales data inquiries with the same AM-100™ system.

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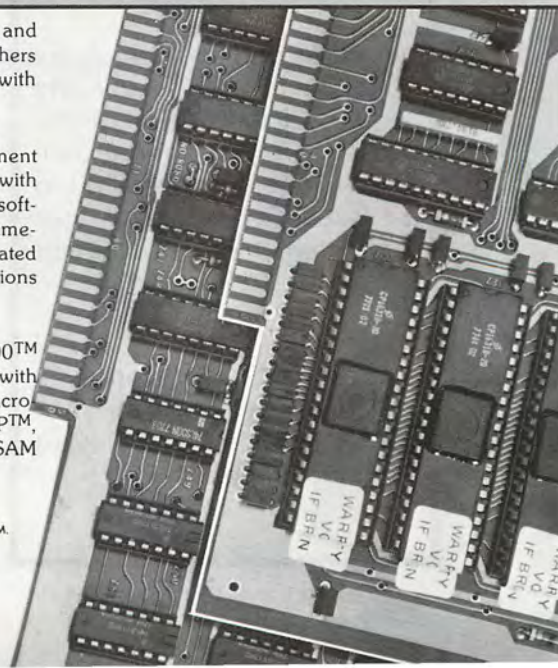
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All system software is licensed to the AM-100™ as part of the system. This includes, along with the operating system AMOST™, a multi-pass Macro Assembler, ALPHABASIC™ compiler, ALPHALISP™, ALPHAFORTH™, ALPHAPASCAL™, SORT, ISAM and various utilities.

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tems Consultants, both deserve a round of applause. Both companies provide 6800 software that is well designed, documented and easy to implement.

One little company that you really don't hear very much about is SOFTECH. The fellows over there are providing some pretty excellent 6502 software and applications for the APPLE. They have just recently started a new marketing campaign to supply tapes of programs for a very nominal charge.

Of course, in any discussion of software venders Digital Research comes to mind. I think it is very safe to say that due to their efforts (CP/M) the use of the microcomputer in business has become a fact instead of a fancy.

Another aspect of software is the place of the consultant. Consultants come in many forms. Some consultants purvey their expertise in books, and some in the traditional consultant-client relationship. David Blair of Microbiz in Long Beach, is of the latter type. David not only provides applications packages written specifically for end-users, but helps in determining just what kind of hardware base fits the user's needs. The consultant, I feel, is really the wave of the future, and really is a must particularly for the small businessman.

FIFO ADS. You have probably realized that when you send your ad in, it doesn't run for around two months. For example, if you send an ad in June, it won't be published until September, and possibly not then. The FIFO is a free service that is subject to drop if we overrun on editorial for a given issue. Therefore, if you think you might sell your equipment within that two month lag period, you might want to reconsider sending the ad in.

CLUBS, we need your correct meeting dates. Send the information to, INTERFACE AGE Magazine, P.O. Box 1234, Cerritos, CA 90701.

Recently, I have had the good fortune to get my hands on a redesigned system from Pertec. Rather than let the cat out of the bag now, I'll just say that from what I have seen so far the system is pretty good. Roger Edelson will be reviewing this revamped system in a future issue, and hopefully by then we will have enough information to talk about the software that goes with it. I hope that gets your interest going, and with a little thought you can probably guess what the system is.

Before I forget, I want to make sure that those of you who live on the east coast will be at the Personal Computing Convention in August. Be sure to drop by the booth and say Hi. carl

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LETTERS TO THE EDITOR

Dear Editor:

I have been an avid reader of *INTERFACE AGE* for over a year now, during which many good words have gone by in your editorials. However, the paragraph advocating that assembler language small business applications will, in your opinion, be the "best possible choice" cannot go unanswered. I am, I should add, an old school assembler programmer from the days when these new-fangled compilers were something that no serious programmer with a whit of professional pride would get within ten feet of. And I believe assembler programmer has its place for systems programming, real-time applications, I/O routines, diagnostic and test procedures, and lots of other places. But I think there are several important reasons why the assembler is rarely the right choice for a small business application.

First, the only thing that's constant in this world is change, to quote an old chestnut, and that is especially true in computer systems. Because of that, it is probably more important to know who wrote the programs you are planning to use, where that person or company is, and where will they be next year when you need the inevitable change or upgrade. Do you get complete documentation with your system that allows you to make changes yourself, or to hire a programmer to make them? Do you get the source code for the application? If there are other related applications that you don't need right away, but may need in the future, are they available? Will they fit with the original one, and use the same files or records? In other words, can your system grow?

Flexibility is an important consideration. If a small business is buying a package that the business will maintain itself, chances are some changes to the package will be desirable. After all, no two businesses are exactly alike. Take payroll, for example — due to no fault or desire on the part of all the businesses who must make payrolls every week or month, the rules of the game change every year predict-

ably. Payroll systems must then change accordingly. Programs written in assembler are probably the hardest for the business to be able to change. Assembler programs seem most susceptible to subtle bugs that creep up in rare cases where you forgot, say, to test the carry flag in a case that only comes up once a year.

Transportability is another important question. Someday, with good luck, the owners are probably hoping that their small business will grow to be a bigger business, and will need a bigger computer of another kind. Assembler programs are the least likely to be easily transported to another type of computer system, and the most difficult and expensive to translate. Starting with a trim, efficient and optimized assembler package, the new computer user may be promising himself a big headache in the future when upgrade time comes around.

Then comes the question of speed. Here assembler programs usually shine compared to higher-level language packages. But I claim that processor execution speed just hardly matters in small business applications. The system is limited by how fast records can come in from a disk, or by how fast a printer can push paper, and rarely are such programs compute bound. The speed advantage of assembler programs seems to me to be unimportant when compared to the improved understanding, clear structure, ease of modification, and transportability that can be achieved with modern higher-level languages.

Let me say in closing, so as not to be totally negative, that if the intent of your paragraph was to note that there must be something better than BASIC for business applications, then I heartily agree. And I think there are several important reasons why BASIC is rarely. . . but that's yet another letter. Given that assembler and BASIC are frequently the only choices, BASIC does have many of the advantages I've mentioned above.

Jerome C. Yochelson
Modular Systems, Inc.

Mr. Yochelson, believe it or not I agree with you almost 100%. In the books and articles that I write I use BASIC. The reason for this is obvious; it is easy to understand, transport and change. However, for the audience that I address, and that most programmers who write articles address, is the group of users who are willing to fool around with an application.

It would appear that I am reversing what I said in my editorial and maybe I am to a degree. But what I was trying to get across, and apparently failed to do, was that the average small businessman operates in an I don't care mode. His primary concern is that the machine performs the job function that it was purchased to do. Consequently, he could care less if the application is written in Sanskrit.

But this seems to be evading the points presented in your letter, and your concern is why I feel assembly language is the better choice. You have partially answered the question. Speed. Also there are the factors of reliability and software protection. Contrary to popular belief, usable high quality software will not be free, or available for the price of a book. Each situation requires the software designer to develop an application that specifically meets his customer's needs. This takes time and money and the software should be protected internally so that it cannot be exchanged among many users.

This is not to say that assembly programs should not or cannot be written in such a manner as to be universal. There is a need for this type of software and it is generated.

I am not advocating a wholesale change from higher level languages to assembly code. Rather the use of both for specific situations. Truly excellent packages have been developed by Space Byte in assembly code, and Structured Systems Group in CBASIC. Both meet the intended user's level of expectation, but both are unchangeable by the end user. The secret lies in the maintenance of the software. The end user should not be expected to

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maintain the software or even be responsible for updates or bug fixing. The designer is the responsible party, except in the case where the software comes from a book or the pages of a magazine.

Who is correct, you or me? I think we are both correct to a degree. Quite honestly I feel that in the real world you have won out. Excellent application software has and is being developed using higher level languages. Designers have found that corrections are easier to make and increases the output of the programmer. In reality no one really loses. I do foresee a number of assembly language business packages coming available in the near future, but with a maintenance contract included.

carl

THE PROBLEM

Dear Editor:

Although I own a KIM-1, I recently ordered Bruce Artwick's 3D software package for the 6800. The package is available for \$28.00 from Sublogic, P.O. Box 3442, Culver City, CA 90230, and is described in KILOBAUD #10 (Oct. 1977) on page 50-57. As the code was advertised as being on a Kansas City Tape, which I cannot read, I deducted \$5.00 from my order and asked that they retain the tape.

I sent a check on March 9, 1978 and they shipped me the 74-page documentation manual on March 14, 1978, with an invoice indicating the deduction for the tape. I then discovered that while the manual contained 5 pages of object code dumps, there was no source listing. Since the article said the source was 2900 lines long, and had possibly been revised since the user manual was printed, I assumed that the source code must have been on the tape (a common practice with bigger machines). I wrote back requesting a copy of the source and received the following letter in reply.

I must admit I feel properly placated, and in full sympathy with the author. Sublogic seems to be a reputable outfit, and I may be among the first to buy these promised versions, once available unless, of course, I write my own equivalent package before then. In fact, the

manual provides enough interface information that I have already begun writing my data base management and I/O routines in anticipation of its availability within my system.

I have been programming in a Computer Assisted Drafting shop for over 18 months now, and was impressed with the clear, concise manner in which Sublogic introduces the fundamental concepts of graphics. I highly recommend the package to any 6800 owner who has graphics hardware on his system, with one small Caveat Emptor. To quote from page 27 of the documentation,

"Unlike many simpler software packages (versions of BASIC, simple games, Star Trek, etc) this 3D package was not intended to be a load-and-go program package. It was intended to be a versatile package of subroutines which, after a lot of system dependent interface work, results in a very useful and advanced piece of customized display software."

I believe the operative word in the last sentence is "customized."

What you get for your money is a set of routines to transform an array of XYZ coordinates of points in space to an array of XY coordinates of points on a 'window', as a function of a matrix which defines the observer's position and view in space. Routines are also included to generate this relative coordinate transformation matrix, or alter it during program execution (thus making it easy to simulate motion). This is the 'system dependent interface work' alluded to, and is trivial enough to be done in BASIC. The Sublogic routines could be in EPROM, and called by a USR function from BASIC.

In short what you need to provide to use it can be done by a 12-year-old, while what you get would be difficult to write without having had a course in Matrix Algebra for the theory and Numerical Methods so it wouldn't take forever to run.

I hope that this letter will suffice for some readers who have been waiting for a product report on this item. Suffice to say that I am not requesting a refund, and do indeed

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feel that I have gotten my money's worth.

D.A. Harrod
Rochester, NY

AND THE ANSWER

Dear Mr. Harrod,

I received your letter of March 26th. Sorry for the delayed response.

A lot of (actually two) other people have bought or attempted to purchase the 6800 3D package with the intention of translating it to 6502 code. If they say that have this intention in their letter (their order), I just return the order with an explanation of the lack of source code.

I often wish I could just start sending out copies of the source to true experimenters such as yourself, but if I do it for one I have to do it for all. The proprietary nature of the source code is only a small part of the reason why I don't distribute it. Three other reasons are:

1. The source would have to be documented a whole lot better than it currently is to be understandable.

2. If I distributed source, people would be constantly modifying it and translating it. A lot of that code is pretty tricky (not instruction modifying tricky, just complex) and I would be hit by a constant barrage of letters with questions why all the modifications and translations don't work. I already get plenty of that just from the few lines of interface source I do supply.

3. My algorithms are very advanced because I have put hundreds of hours into making them extremely efficient. I did my masters thesis on 3D graphics and developed a lot of ideas there. A lot of them I developed on my own time. If I described my algorithms, they would soon be popping up in items such as electronic arcade games, and I wouldn't be getting any recognition for my work. You can copyright code, but not an algorithm.

At any rate, there are people who think my source code is worth something (more than \$5.00 at least). I am currently negotiating selling a copy of the Z80 source code to an electronic games manufacturer for a few thousand dollars. It really wouldn't be right to

sell it behind their backs to hobbyists for 5 dollars.

As for the idea of \$23.00 being too much to pay for a piece of object code, I agree; if it doesn't run on your computer that is. People who have bought the 6800 package for use on the 6800 system have for the most part been very satisfied with it. I am not making wild profits off this software. As a matter of fact I lost a few hundred dollars on it in 1977. I hope to do better this year. You may be thinking that the reason I didn't do so well is because the price is too high, but this isn't so. The demand for 3D graphics software in an experimenter's package just isn't that great.

I'm sorry I have to turn down your request for source. If you really feel you have paid too much and the package is useless to you, please return it to Sublogic Distributin in Savoy for a refund.

P.S. Sure you can disassemble the code, but I think it would take you longer to figure out what was going on from the disassembler output than it would to develop a whole graphics program from scratch. The idea of not supplying source isn't to make it impossible to tear apart; it's just to make it not worthwhile.

Bruce Artwick
Sublogic
Culver City, CA

Dear Editor:

As a subscriber, I have noted with interest the rising percentage of editorial effort addressed to small business usage of computer products and services, and some advice would be appreciated.

Recently, I rescheduled a planned business trip to Seattle to permit attendance at the "Computer Faire" to be held there. I should say "so-called computer faire," as it turned out to be a large roomful of small computers, all addressing themselves to offering the most sophisticated versions of "Star Wars" to be had in the world today. Nobody, and I mean NOBODY there seemed to have the slightest interest in talking small business applications using real money, and I left Seattle essentially in the same position computerwise as I arrived.

OK. You have convinced me. The small computers today sure do play a fine game of Star Wars, and with

ingenuity can also turn the oven on and off, something my oven's timer has done handily for decades. My question is, without going into a \$100K IBM System 32, is there *anyone* out there who is *totally* and *completely* involved in the development of small business hardware and software applications to the extent that they have *no* time to goof around developing newer, glossier and more dazzling toy games?

I am a salesman, marketing securities services to a growing clientele. Accounts are growing in numbers rapidly and we have trouble keeping track of them, following up on the dates we have been asked to, and sorting out the mailing list for specialized mailings on selected topics. No big deal, really, and since the buck invested are at once deductible in my 60.5% income tax bracket, it is not really a matter of finding the bottom dollar cost. If we bought everything by the pound, we would have married the girl who weighed the most, a subtlety which the rank-and-file of computer sales people have yet to learn.

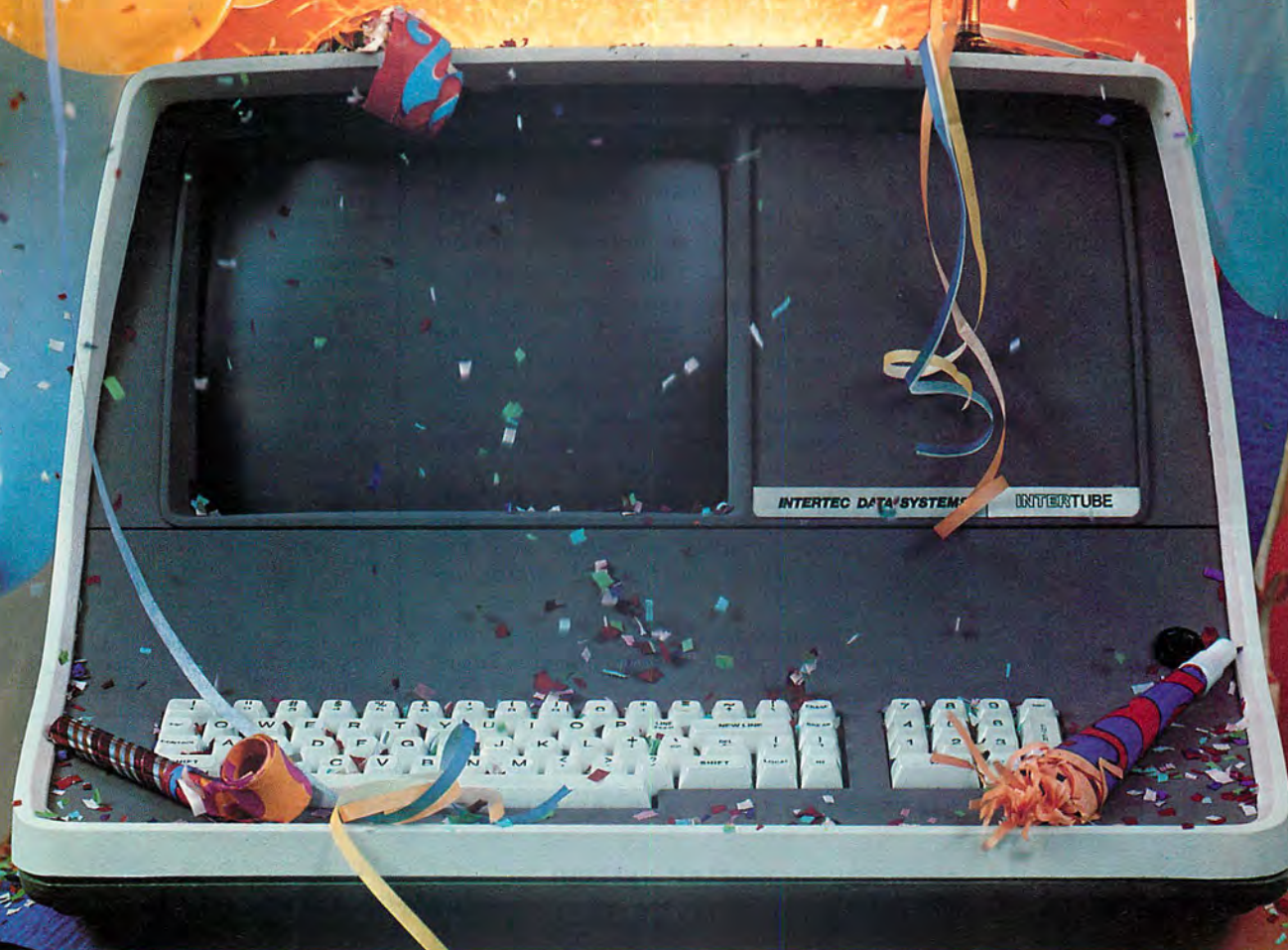
My second request involves the "level" of product sophistication assumed for your readership, a level which I have not quite attained. More importantly, I am not even certain that I *want* to attain it, so I am asking advice as to whether there is another publication suited to my needs. I trust you are professional enough to answer candidly, as one subscription more or less shouldn't make or break you at this point.

There is an old axiom in sales training that every year in America they sell about 1 million ordinary quarter-inch drill bits, and yet nobody who buys one of those quarter-inch drill bits wants it.

What they want is a quarter-inch hole.

I detect a substantial amount of your magazine content is applied to fine points of programming, which would probably delight a programmer, but which to the uninitiated are akin to determining how many angels can dance on the head of a pin. Again getting selfish, my own interests lie more in locating sources of systems which have already looked the field over, and have advanced to the user-oriented stage of concept. In other words,

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supplying the right bit to drill a hole in a specified kind of metal rather than giving me the metallurgical formulae for all the drill bits they manufacture so I can study up to see which one is best suited to, say, drilling stainless steel.

I admit to very limited computer expertise, being your fairly casual, Hewlett-Packard HP-67/97-type programmer. For me, using flags and mastering indirect addressing constitute high-level stuff and involve learning more about the subject than I really wanted to know. Your suggestions will be most appreciated.

Richard Scott
Fairbanks, Alaska

Whew! I would like to think and hope that by the time you get this issue of INTERFACE AGE, you will have found the articles that interest you and have met your interest level.

We realize that it can be very disenchanted to be expecting some-

thing really great and wonderful from these crazy little boxes, and be presented with a better way to play Star Trek. Also when you want to find something that tells you how, and find it full of technical jargon it becomes even more unsettling.

We can't really promise that we will always deliver you the quarter inch hole, but we will give you the bit and the brace to get it started with.

We hope by the time you read this you will have had a chance to read the Editorial Conference in the June issue. From it you should get a basic idea of just what the other magazines are about. As a suggestion, you might consider subscribing to one or more of these magazines, which you really should, to get that well rounded education you are seeking in the field of microcomputing.

Hopefully this has answered your questions or at least let you know we care.

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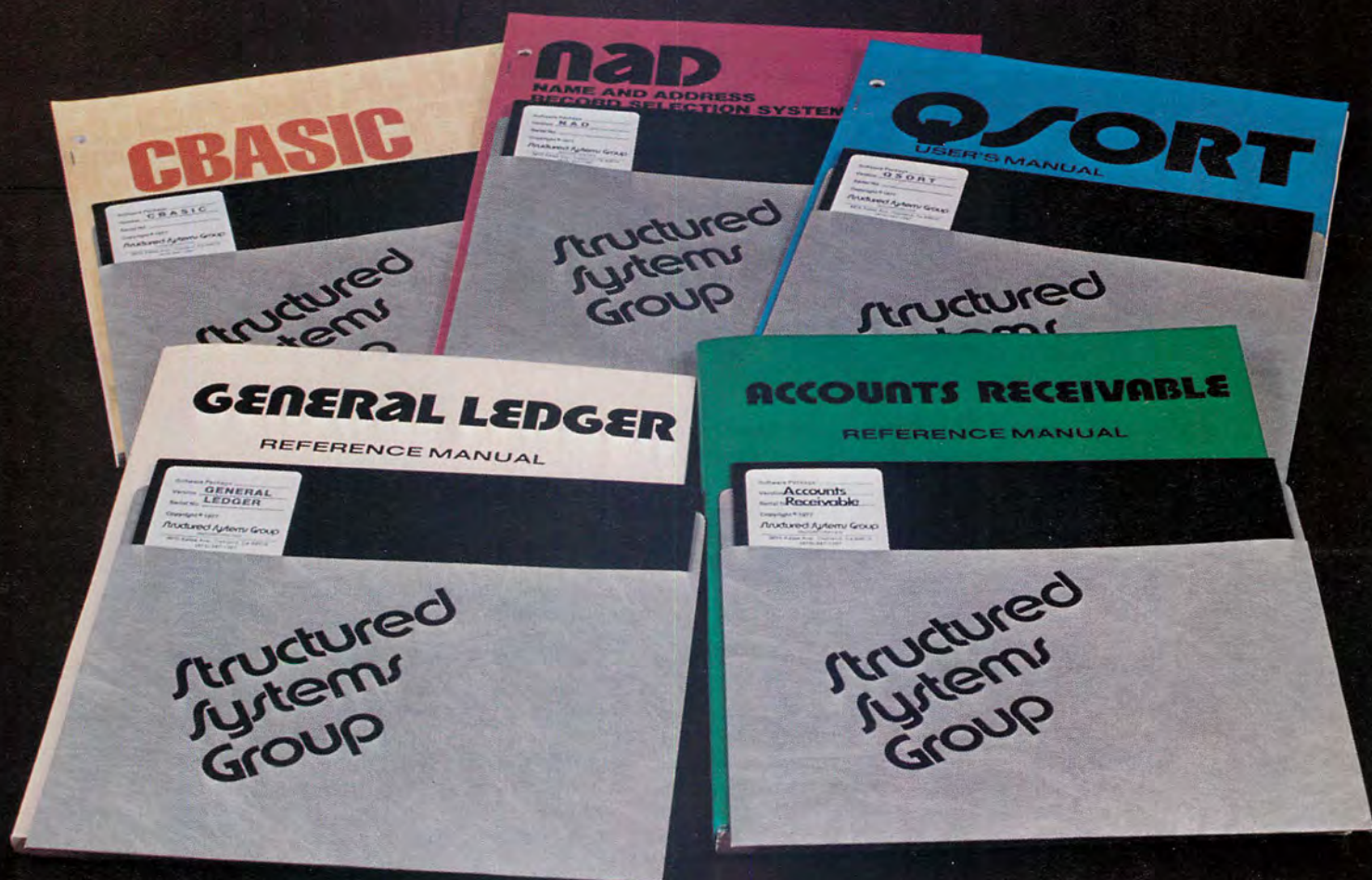
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Our growing Business Systems series currently includes: **GENERAL LEDGER**, **ACCOUNTS RECEIVABLE**, **NAD** (Name and Address File system), **QSORT** (full disk sort/merge), and **CBASIC** (a powerful business Basic). For details, contact our sales manager, Richard Ellman.

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CENTRONICS PRINTERS AID CHECK-IN AT NEW YORK'S FINEST HOTELS

In a 900-room hotel with an occupancy rate that consistently hovers around 85%, guest registration can be a time-consuming, costly operation. To circumvent this problem, the Biltmore and Roosevelt Hotels in New York — which between them contain more than 1,900 rooms — are using an automated hotel management system and two Centronics 306 printers to facilitate day-to-day operations and to "preregister" guests who make their room reservations by telephone.

Dubbed HOST — for Hotel On-Line System Technique — the hardware/software package is available from NCR and consists of a Century 201 computer and more than 50 CRT terminals. The 306 printers were simply "plugged in" to enable hotel employees to perform other functions more vital to the daily well-being of the hotel's guests.

In practice, the system actually swings into action even before a prospective guest completes his telephone reservation request.

Reliability was another reason why the 306 was selected for the system. If, for example, an individual claiming to have a confirmed reservation suddenly appears at the front desk, he doesn't want to hear that because the printer was down he can't be provided with a room. Thus far, however, the 306 has done all that's been asked of it and more, which makes for a smooth-running, profitable hotel operation.

SHORT COURSE SERIES IN MICROCOMPUTER/DIGITAL ELECTRONICS

The introduction of the microcomputer has literally created a revolution in the electronics industry. Trenton State College is offering three short courses during the week of August 21 designed to meet the needs of engineers and computer scientists as well as individuals interested in the areas of microcomputers and digital electronics. These courses will be of equal value to computer scientists who must use and design microprocessor-related hardware and the individual who simply wishes to learn more about digital electronics or use a microcomputer for personal applications as in hobby computing.

Each of the courses will cover approximately the same ground as a

normal one-semester college course, and will be presented in the form of an intensive, fully-documented lecture coupled with laboratory sessions. All classes are limited to a maximum of 20 participants, and will meet from 9:30 to 5:00 Monday through Thursday and from 9:30 to 1:00 on Friday. Additional supervised open laboratory time will be provided every evening. Participants may earn college credit. On-campus housing and meals are available.

For further information and registration forms, contact the Division of Continuing and Adult Education at Trenton State College, or call (609) 771-2255.

MICROCOMPUTERS IN MEDICINE TO GIVE RISE TO \$1.3 BILLION MARKET OVER NEXT DECADE

The sales generated by microcomputer-based medical system will cumulatively total \$1.3 billion over the next ten years, finds a 329-page study by market researchers Frost & Sullivan Inc., in New York City.

"Not only will microcomputer systems find a place in medical applications not now covered by minicomputers, but it also is evident that the micro will invade current minicomputer markets as well," the study says, adding advanced microtechnology will radically change the traditional market profile.

The study, entitled "Medical Microcomputer Markets," explores clinical lab, medical information, and administrative data processing.

Responses to a survey from 300 medical equipment manufacturers, physicians, hospital administrators, and health professionals identify more than 55 emerging medical developments that lend themselves to microcomputer power and, accordingly, appear likely to stimulate the new uses of computer systems.

For more information contact Customer Service, Frost & Sullivan Inc., 106 Fulton St., New York, NY 10038, (212) 233-1080. Reference Report No. 449.

SBS PUBLISHING ANNOUNCES MARKETING RESEARCH SUBSCRIPTION SERVICE FOR SMALL BUSINESS SYSTEMS

SBS publishing announced the availability of its *Marketing Advisory Subscription Service*, M.A.S.S. The M.A.S.S. program will be unique in the data processing industry

because it will provide information based on in-depth interviews with prospects for data processing products and services.

Subscribers will receive seven industry reports, a yearly overview of the industries on an aggregate level and a special report on vendors. These reports will be further supplemented by an annual small business marketing conference, and subscriptions to the *Small Business Systems Industry Report*.

The *Marketing Advisory Subscription Service* annual subscription is \$7,500 and additional information can be obtained from Mr. Jules Street, Vice President, SBS Publishing, 4320 Stevens Creek Blvd., Suite 190, San Jose, CA 95129, (408) 243-8121.

AMATEUR COMPUTING 78

Amateur Computing 78 microcomputer festival will be held July 22-23 at the Sheraton National Motor Hotel, Columbia Pike and Washington Boulevard, Arlington, Virginia.

The show will feature commercial exhibits, personal computer displays, seminars and club activities. Computer hobbyists and the general public are welcome.

Registration at the door for two full days is \$5.00 (spouse and children of ticket holder admitted free). If not sold out, Saturday night banquet tickets are \$14.00 per person if purchased at the show. To avoid delays and to save money, admission tickets are \$4.00 and the banquet tickets are \$12.00 per person if ordered in advance by mail. Send check payable to AMRAD to P.O. Box 682, McLean, VA 22101.

COSMAC-1802 USER'S GROUP

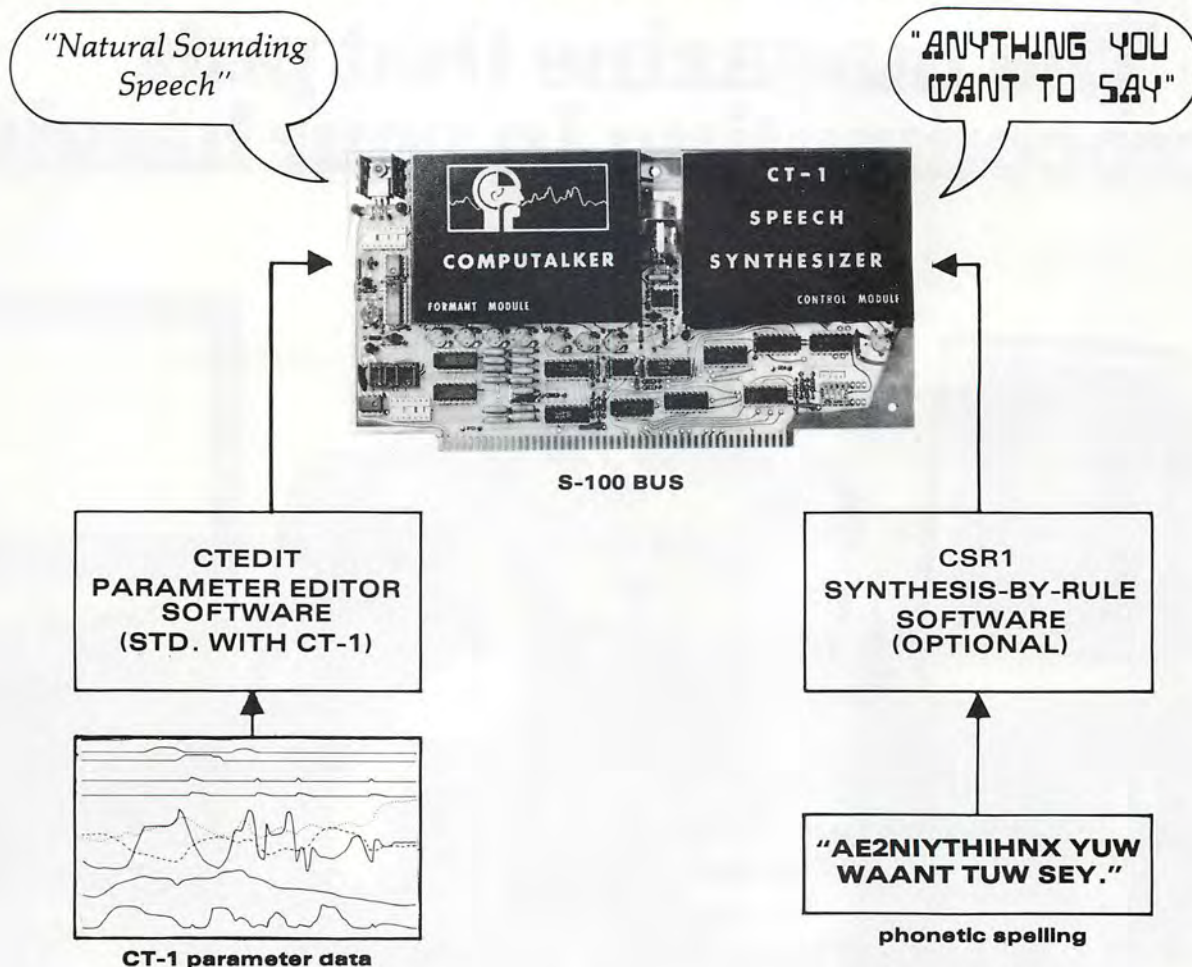
A COSMAC-1802 User's Group is being formed. Membership is FREE, and is open to all 1802 users, including Basic ELF, ELF-2, Super-ELF, VIP, UC-1800, etc. We will correspond, exchange ideas and software, and possibly publish a newsletter. Write to: Patrick Kelly, P.O. Box 7162, Los Angeles, CA 90022.

PORTIA ISAACSON TO EDIT PRENTICE-HALL PERSONAL COMPUTING SERIES

Portia Isaacson, personal computing expert, has joined Prentice-Hall as series editor and advisor for the firm's newly launched *Personal Computing Series*.

Dr. Isaacson will strive to edit a

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The optional CSR1 software package translates ASCII phonetic text strings to speech output. CSR1 is simple to use and is the easiest way to create new speech. CSR1 can also be called as a subroutine from user's code for applications involving program controlled voice output.

The CSR1 phonetic rule system generates control parameters in the same form as used by CTEDIT. Thus, it is possible to further edit the output of the rule system, to achieve natural sounding speech output with minimum effort.

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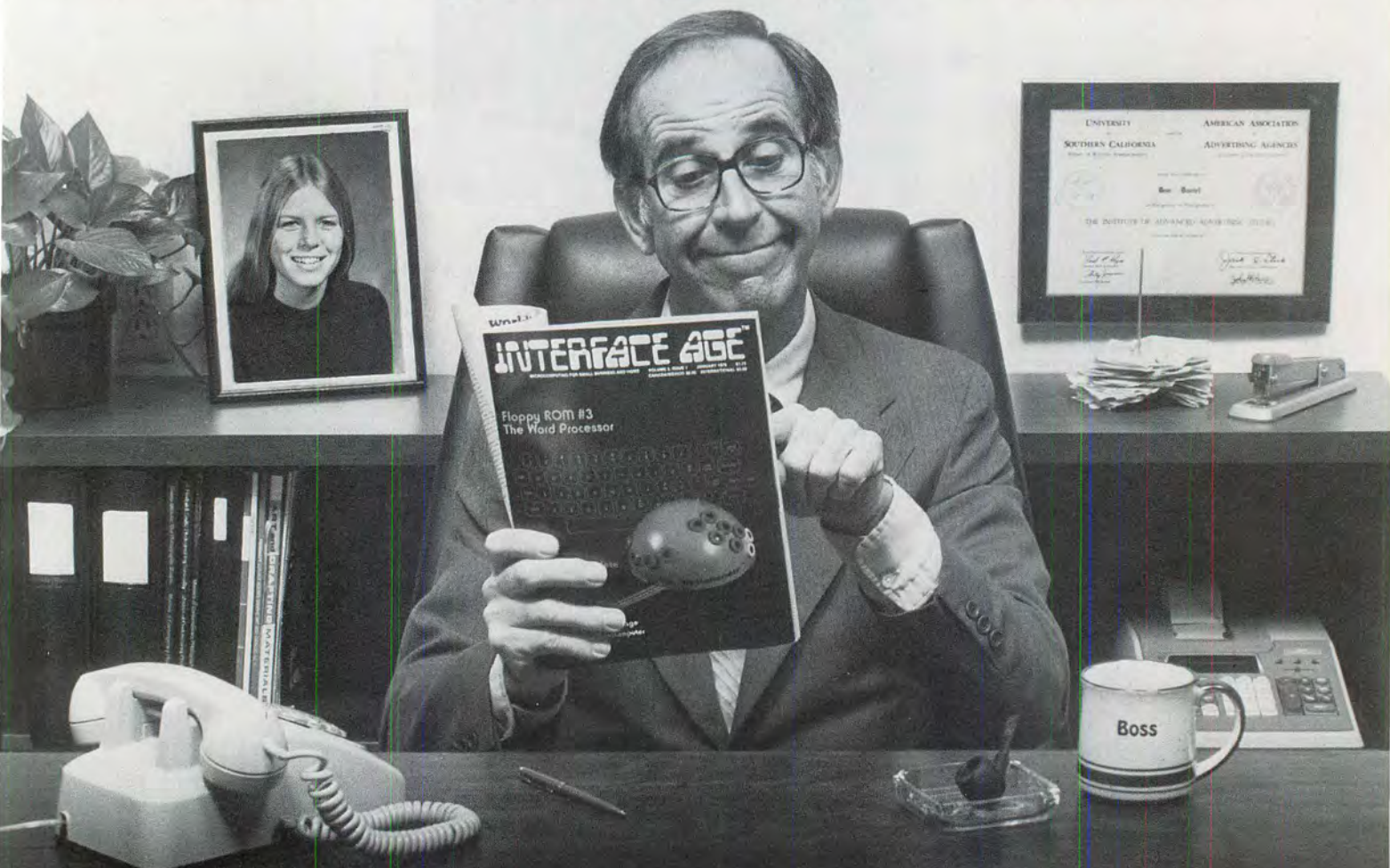
Software is available on CPM 8",
North Star 5 1/4", CUTS, TARBELL,
MITS ACR, Paper Tape.

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Articles ranging from the fundamentals of computers to languages and system design, tutorials, activities, and new product releases to help you get started in microcomputing and keep up with the industry.

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Series which will be of consistently high quality and reliability. She and Paul Becker, Prentice-Hall's Personal Computer Editor, will work together to produce books on topics for specific interest groups as well as books of general interest for all small computer enthusiasts. She will author the first book in the Series, *The Microcomputer In Business* and is presently seeking authors for tutorial and reference books for the Series.

SC/MP USERS GROUP

The formation of this users group is centered around those hobbyists who have or plan to acquire an SC/MP or SC/MP-II based computer system.

No dues or fees are involved. The only cost to the members is for the self-addressed, stamped envelope he or she mails for use in mailing out the monthly newsletter.

A library of software and hardware information has been formed and will be made available to the members at a cost basis. A bibliography is being compiled which is to contain everything available about the SC/MP — articles, advertising, programming hints, etc. Again, this is available to any member for the reproduction costs.

If sufficient interest is shown, it is

planned to construct a 'homebrew' system based on the versatile SC/MP-II and using a common bus structure. This will be accomplished by articles in the newsletter and assistance to members experiencing difficulty in constructing the system from the articles.

For more information contact Tom Bohon, 2215-A Walker Dr., Omaha, NE 68123.

TRAINING PROGRAMS EXPANDED

National Semiconductor has expanded its training programs for Engineers and Managers. This program consists of a spectrum (fundamentals to complex peripheral chips) of microprocessor workshops offered at National's Santa Clara, California training center and the new Bedford, Massachusetts training center.

A brochure describing each course in detail is available by writing to National Semiconductor Corp., Training M/S 470, 2900 Semiconductor Dr., Santa Clara, CA 95150, or calling National Semiconductor training (408) 737-6453.

REMOTE SC/MP MICROPROCESSOR MONITORS AIR QUALITY, UNATTENDED

Air pollution control agencies in

Santa Barbara and San Luis Obispo Counties in California are getting a better look at ambient-air quality thanks to an extensive system of remote microprocessor-based data acquisition, conversion and logging equipment. Using National Semiconductor Corporation's SC/MP microprocessors, the instruments continuously measure sulfur dioxide, and hydrogen sulfide pollution, wind direction and speed, and temperature in ten new locations throughout the two-county area.

Oxides of sulfur in the atmosphere generally result from burning hydrocarbon fuels with a natural sulfur content or from industrial or petrochemical processes. At specified ambient concentrations, these oxides can produce health problems such as pulmonary disease in some people.

Previously, only incomplete data from limited monitoring was available for planners and regulatory agencies in the area. Oxides of sulfur levels were recorded on analog charts for later reduction and analysis. While accurate, the data were indicative only of specific areas, and extrapolation over wider areas was inconclusive.

To obtain more information, the Santa Barbara County Air Pollution Control District, San Luis Obispo Air

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The package is now under development. It will be available in various versions of BASIC. It has COMPLETE DOCUMENTATION containing over 200 pages. It is designed by Experienced Systems Analysts, written by Experienced Programmers. It is not the typical System.

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AND FOR THOSE WHO ARE WAITING

As you probably know, NSE has undergone a change in structure. Since our initial advertisements last year, we've been shocked, amazed, and transformed by the small computer software market.

We discovered long ago that Application's Programming is the most vital—and most neglected area in the Micro World. We then set out to fill that void with existing programs offered on a commission basis. After several frustrating months, we realized the GRIM REALITY—WELL WRITTEN, SALEABLE AP'S did not even exist. So we began the slow process of program system development—PRELIMINARY ANALYSIS, STRUCTURE DESIGN, FINAL DETAIL DESIGN, CODING, DOCUMENTATION and TESTING. IT TAKES MONTHS, but the final Package is well worth waiting for. THE BUSINESS SYSTEM will be here soon. For those who have been waiting since last year— Thanks. The wait is almost over and it's been worth it. For those who are just now getting acquainted with us, hang on—we'll be there shortly—and what a reward.

 National
Software
Exchange, Inc.

**THE SMALL COMPUTER
SOFTWARE PEOPLE**

Pollution Control District, and the Environmental Research Foundation initiated an extensive air-monitoring program in Northern Santa Barbara County and San Louis Obispo County, purchasing ten remote data logging instruments from Martek Instruments, Newport Beach, California. The year-long study will provide accurate quantitative and qualitative analyses of atmospheric oxides of sulfur levels on an hour-by-hour basis.

The study promises to provide much-needed and well documented air-quality information that might be impossible to obtain economically by conventional means. For information concerning the Martek DMP-411C data logging instrument contact Market Instruments, 17302 Daimler St., Irvine, CA 91713, (714) 645-1170.

GRINNELL COLLEGE WINS SECOND MIDWEST REGIONAL PROGRAMMING COMPETITION

Grinnell College of Grinnell, Iowa barely nosed out DePauw College of Greencastle, Indiana in the Second Midwest Regional Programming Competition held at Taylor University, Upland, Indiana in April. The host team, Taylor, finished third, and Wabash College of Crawfordsville, Indiana was fourth. Grinnell's two person team lead by Scott Parker of Champaign, Illinois and sponsored by Professor Mark Grundler defeated DePauw College by only three points in the four person, four hour competition using Taylor University's DEC time-sharing system.

However, Evansville University used their IBM 360 over telephone lines for the competition.

Each team had only one 300 character per second printing terminal on which to write, test and debug their programs. A team of six judges reviewed the solutions written in the BASIC language and indicated if the solutions were correct or incorrect. The scoring method includes the number of problems, the time required to complete the solution, and the number of judged runs submitted.

In addition to the four teams already mentioned, others competing were the University of Wisconsin/Platteville, Asbury College of Kentucky, plus Grace College and Rose-Hulman Institute from Indiana.

Next year the Midwest Regional will be held at Rose-Hulman or Taylor University. It is hoped that a National BASIC competition between regional champions will be held at a later date.

6800 USERS CLUB

A 6800 Users Club has been formed for the Dallas/Fort Worth, Texas area and meets on the third Thursday of each month at 7:00 P.M. at 1220 Majesty, Dallas, Texas. All parties interested in attending are cordially invited to do so. We are currently presenting varied topics of interest to users of the 6800 systems along with tutorials in Assembly Programming.

Also of interest to users of 6800 systems where no local Users Group exists might be our "Ask the Chips" feature where any questions or comments concerning the 6800 systems

are presented to the club during meetings and discussed. Any user worldwide may correspond at the address listed below and we will make every attempt to respond with any solution we might have discovered.

We also feature a "Tell the DIPs" portion of meetings where manufacturers, software suppliers, or others desiring a forum to present ideas to a club may send brochures for distribution or address the club directly.

For further information contact Charles A. Matz, 4114 Avondale, Suite 2, Dallas, TX 75219, or phone evenings (214) 522-7130.

INTERNATIONAL MICROCOMPUTER EXPOSITION

The International Microcomputer Exposition in Dallas (September 29-October 1) will feature a unique Panel of Experts. This panel will consist of qualified experts in the fields of software, hardware and design.

The Panel will be located on the Exhibit floor during all show hours. They will field questions from Exposition attendees concerning all facets of microprocessing and small systems. The Panel members are excited about the exchange of ideas and it promises to be one of the highlights of the year in microprocessing.

The Panel of Experts will be able to field questions pertaining to both industrial/business applications and personal computing — from simple to complex. There is no charge to attendees for this forum to discuss problems and design.

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Enter the Siliconix CODEC Design Contest and win an Apple II — the world's best-selling personal computer — or another great prize. All you have to do is use Siliconix' CODEC to design a microprocessor-based system which responds to your spoken words (or talks back to you). Our CODEC is a two-chip set: the DF331 coder is a high-speed serial output A/D converter — a complete subsystem-on-a-chip; the DF332 decoder converts high-speed digital bit streams into analog signals. The system you design must be capable of understanding or speaking at least 16 words.

Here's what you can win:

1st prize: Apple II personal computer (retail value \$1,445). A completely self-contained computer system with high resolution color graphics in 15 colors (with color TV); BASIC in ROM, 16K bytes of RAM, built-in video interface, cassette I/O, four A/D inputs with two game paddles supplied, eight peripheral slots, three TTL inputs and four TTL outputs. Apple II plugs into any standard TV using a modulator.

2nd prize: Siliconix LCD Stopwatch-In-A-Wristwatch. Features time, day, date, plus split timing stopwatch functions.

3rd prize: Siliconix LED Stopwatch. Includes split timing function.

4th prize: Siliconix Telephone Timer. Includes start/stop and timeout.

5th prize: Siliconix LED Stopwatch. Features a digital start/stop timer.

All entries must be accompanied by our official entry blank. Get yours, along with complete contest rules, data sheets and other information, by filling out the coupon below.



& WIN an Apple!®



Mail to:

Siliconix CODEC Design Contest
2201 Laurelwood Road
Santa Clara, CA 95054

Yes, I want to know more about the Siliconix CODEC Design Contest. Please send me details and the official entry blank.

Name: _____ Title: _____

Company: _____ (Optional)

Address: _____ Mail Station: _____

City: _____ State: _____ Zip: _____

IA 7/78

Why Apple II is the world's best selling personal computer.

satisfaction a personal computer can bring, today and in the future.

15 colors & hi-resolution graphics, too.

Don't settle for a black and white display! Connect your Apple to a color TV and BASIC gives you instant command of three display modes: Text, 40h x 48v Color-graphics in 15 colors, and a 280h x 192v High Resolution array that lets you plot graphs and compose 3-D images. Apple gives you the added capability of combining text and graphics, too.

Back to basics, and assembly language too.

Apple speaks three languages: fast integer BASIC, floating point BASIC for scientific and financial applications, and 6502 assembly language. That's maximum programming flexibility. And, to preserve user's space, both integer BASIC and monitor are permanently stored in 8K bytes of ROM, so you have an easy-to-use, universal language instantly available. BASIC gives you graphic commands: COLOR=, VLIN, HLIN, PLOT and SCRIN. And direct memory access, with PEEK, POKE and CALL commands.

Software: Ours and yours.

There's a growing selection of pre-programmed software from the Apple Software Bank — Basic Finance, Checkbook, High Resolution Graphics and more. Now there's a User Section in our bank, to make it easy for you to obtain programs developed

owners on top of what's new.

Apple is so powerful and easy to use that you'll find dozens of applications. There are Apples in major universities, helping teach computer skills. There are Apples in the office, where they're being programmed to control inventories, chart stocks and balance the books. And there are Apples at home, where they can help manage the family budget, control your home's environment, teach arithmetic and foreign languages and, of course, enable you to create hundreds of sound and action video games.

When you buy an Apple II you're investing in the leading edge of technology. Apple was the first computer to come with BASIC in ROM, for example. And the first computer with up to 48K bytes RAM on one board, using advanced, high density 16K devices. We're working to keep Apple the most up-to-date personal computer money can buy. Apple II delivers the features you need to enjoy the real

Which personal computer will be most enjoyable and rewarding for you? Since we delivered our first Apple® II in April, 1977, more people have chosen our computer than all other personal computers combined. Here are the reasons Apple has become such an overwhelming favorite.

Apple is a fully tested and assembled mainframe computer. You won't need to spend weeks and months in assembly. Just take an Apple home, plug it in, hook up your color TV* and any cassette tape deck — and the fun begins.

To ensure that the fun never stops, and to keep Apple working hard, we've spent the last year expanding the Apple system. There are new peripherals, new software, and the Apple II Basic Programming Manual. And wait till you see the Apple magazine to keep



by other Apple owners. Our Software Bank is your link to Apple owners all over the world.

Alive with the sound of music.

Apple's exclusive built-in speaker delivers the added dimension of sound to your programs. Sound to compose electronic music. Sound to liven up games and educational programs. Sound, so that any program can "talk" back to you. That's an example of Apple's "people compatible" design. Another is its light, durable injection-molded case, so you can take Apple with you. And the professional quality, typewriter-style keyboard has n-key rollover, for fast, error-free operator interaction.

Apple is the proven computer.

Apple is a state-of-the-art single board computer, with advanced LSI design to keep component count to a minimum. That makes it more reliable. If glitches do occur, the fully socketed board and built-in diagnostics simplify troubleshooting. In fact, on our assembly line, we use Apples to test new Apples.

*Apple II plugs into any standard TV using an inexpensive modulator (not included).

**In California, call 408/996-1010.



Apple peripherals are smart peripherals.

Watch the far right column of this ad each month for the latest in our growing family of peripherals. We call them "intelligent interfaces." They're smart peripherals, so you can plug them in and run them from BASIC without having to develop custom software. No other personal computer comes close to Apple's expandability. In addition to the built-in video interface, cassette I/O, and four A/D inputs with two continuously variable game paddles, Apple has eight peripheral slots, three TTL inputs and four TTL outputs. Plus a powerful, state-of-the-art switching power supply that can drive all your Apple peripherals.

Available now.

Apple is in stock and ready for delivery at a store near you. Call us for the dealer nearest you. Or, for more details and a copy of our "Consumer's Guide to Personal Computers," call

800/538-9696** or write Apple Computer, Inc., 10260 Bandle Drive, Cupertino, CA 95014.



Programming is a snap! I'm halfway through Apple's BASIC manual and already I've programmed my own space wars game.

Those math programs I wrote last week—I just rewrote them using Apple's mini-assembler and got them to run a hundred times faster.

New from Apple.

Introducing Disk II™: instant access to your files.

Our newest peripheral is Disk II, a high-density 5 1/4" floppy disk drive for fast, lowcost data retrieval. It's perfect for storing large bodies of data such as household finances, address files and inventories; you can find any record in just half a second. No more searching through

stacks of cassettes; with a few keystrokes, your system will load, store and run any file by name.



Disk II consists of an intelligent interface card, a powerful Disk Operating System (DOS), and one or two

minifloppy drives. Your Apple will handle up to seven interface cards and fourteen drives, for control of nearly 1.6 megabytes of data, with no expansion chassis. The combination of ROM-based bootstrap loader and an operating system in RAM provides complete disk handling capability, including these special features:

- Soft sectoring • Random or sequential file access • Program chaining capability
- Universal DOS command processor works with existing languages and monitor
- Full disk capability in systems with as little as 16K RAM • Storage capacity: 113 kilobytes/diskette.

See Disk II now at your Apple dealer. Sold complete with controller and DOS at \$495.†

Peripherals in stock

Hobby Board (A2B0001X), Parallel Printer Interface (A2B0002X), Communication Interface (A2B0003X), Disk II (A2M0004X).

Coming soon

High speed Serial Interface, Printer II, Printer IIA, Monitor II, Modem IIA.

†Price subject to change without notice.

CIRCLE INQUIRY NO. 4 FOR APPLE
CIRCLE INQUIRY NO. 5 FOR DISK II

Apple's smart peripherals make expansion easy. Just plug 'em in and they're ready to run. I've already added two disks, a printer and the communications card.

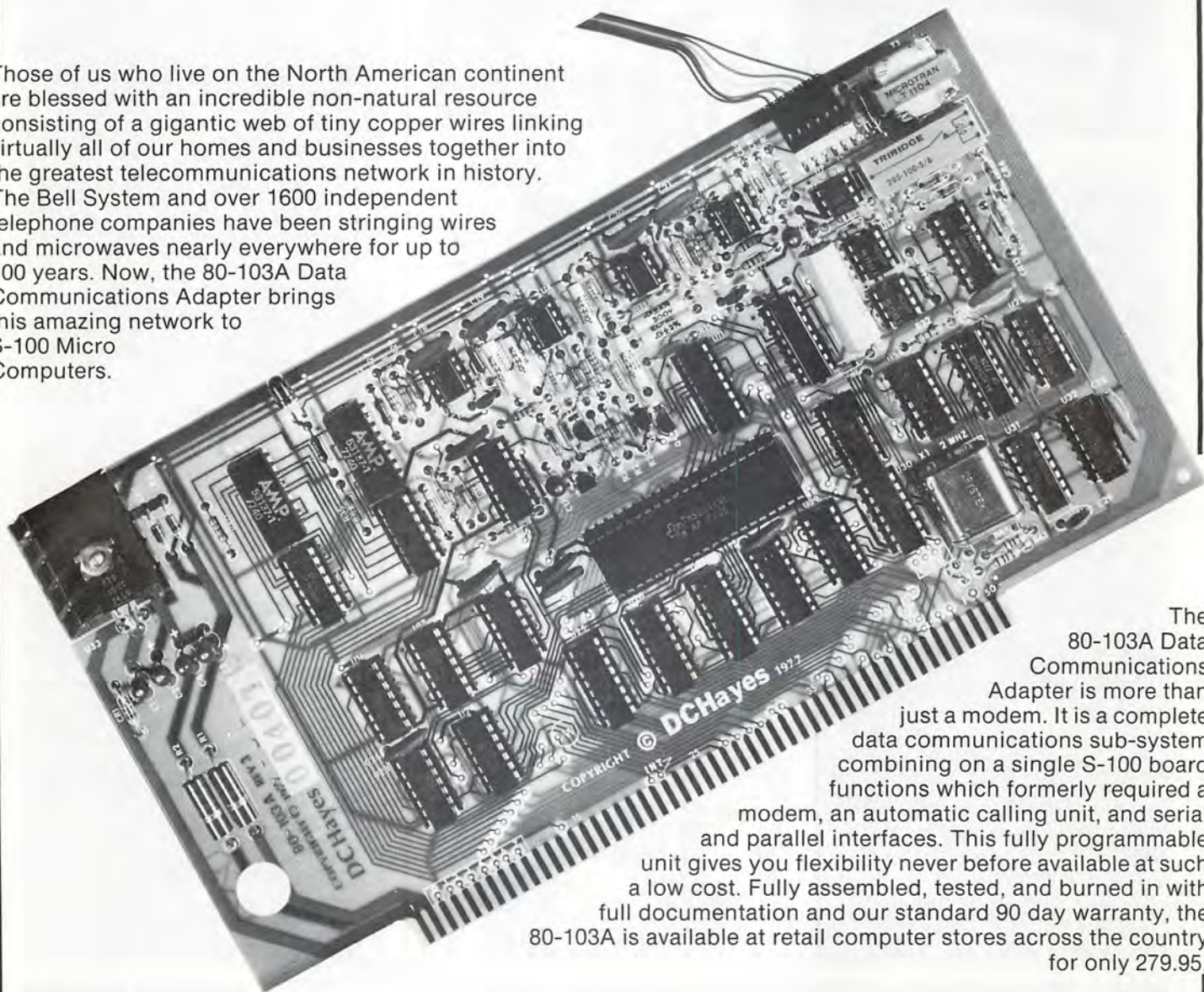


CALENDAR

- Aug 1 Tidewater Computer Club will meet at the Electronic Computer Programming Institute, Janaf Office Bldg., Janaf Shopping Center in Norfolk. The club also meets on the 3rd Tuesday of the month. For details contact: C. Dawson Yeomans, Interface Chairman, 677 Lord Dunmore Dr., Virginia Beach, VA 23462.
- Aug 2 New England Computer Society will meet in the cafeteria of the MITRE Corp. at 7:00 P.M. Located on Route 62 in Bedford, MA. Contact Dave Day at (603) 434-4239 for details.
- Aug 2 Kitchener Waterloo Microcomputer Club will meet at the University of Waterloo, Room 3388, Engineering Bldg. #4, University Ave., Waterloo, Ontario, Canada at 7:30 P.M.
- Aug 2 The Valley Computer Club will meet at 7 P.M. at the Harvard School located at 3700 Coldwater Canyon, Studio City, CA.
- Aug 2 Columbus Computer Club will meet at the Center of Science and Industry at 7:30 P.M. For further information write c/o Fred Hatfield K8VDU, Computer Data Systems, 1372 Grandview Ave., Columbus, OH 43212, or call (614) 488-3347.
- Aug 2 Lincoln Computer Club will hold its meeting at the South Branch Library located on 27th and South Sts. at 7 P.M. For more details write Hubert Paulson, Jr., 422 Dale Dr., Lincoln, NE 68510.
- Aug 3 Bay Area Microprocessors Users Group (BAMUG) will meet in the Hayward ROC Center, 26316 Hesperian Blvd., Hayward, CA at 7:30 P.M. For further details write BAMUG, 1211 Santa Clara Avenue, Alameda, CA 94501.
- Aug 3 Northwest Computer Society meets in the Pacific Science Center in Seattle, Room 200 at 7:30 P.M. The club also meets on the third Thursday of the month. For more details write NCCN, Box 242, Renton, WA 98055.
- Aug 3 Microcomputer Users Group (MCG) will hold its meeting at the University of Minnesota, Electrical Eng. Rm. 115 at 7 P.M. The club meets every Thursday. For more information write MCG, Dept. of Elec. Eng., 123 Church St. S.E., Minneapolis, MN 55455.
- Aug 4 Crescent City Computer Club will hold its meeting at the University of New Orleans, Lakefront Campus at 8 P.M. Call Bob Latham at (504) 722-6321 for more details.
- Aug 4 Microcomputer Information Group will meet at 7 P.M. at the Microcomputer Resource Center, 5150 Anton Dr., Rm. 212, Madison, WI 53719, (608) 274-8925. Len Lindsay, president.
- Aug 5 Louisville Area Computer Club (LACE) will meet at the University of Louisville, Speed School Auditorium at 1 P.M. For details, write the club at 115 Edgemont Dr., New Alban, IN 47150.
- Aug 5 The Computer Hobbyist Group will meet at 1 P.M. in the Green Center, Rm 2.530, of Univ. of Texas, Dallas. For details write to P.O. Box 11344, Grand Prairie, TX 75051.
- Aug 5 South Central Kansas Amateur Computer Association, 9:00 A.M., Wichita Public Library, Wichita, KS. For further information call Chris Borger at (316) 265-1120 or Dave Rawson, 1825 Gary, Wichita, KS 67219, (316) 744-1629 for further details.
- Aug 5 Oklahoma Computer Club will be meeting at the Belle Aisle Library at 10 A.M. Call Al Campbell at (405) 842-4933 for details.
- Aug 5 Milwaukee Area Computer Club will meet at 1 P.M. at the Waukesha County Technical Institute, New Berlin, WI. Call (414) 246-6634 for further details.
- Aug 5 Southern Nevada Personal Computing Society will meet at Clark County Community College, Las Vegas, NV at 12:00. The club also meets on the 3rd Saturday of the month. For further information write SNPCS, 1405 Lucille St., Las Vegas, NV 89101 or call (702) 642-0212.
- Aug 7 Minnesota Computer Society will meet at the Brown Institute, Room 51, 3123 E. Lake Street, Minneapolis, MN. For further information contact the Society at Box 35317, Minneapolis, MN 55435, Attn: Jean Rice.
- Aug 8 Okaloosa Computer Hobbyist Club will meet in the Community Room of the First Federal Savings & Loan Assoc. of Okaloosa County, 158 Elgin Pkwy N.E., Ft. Walton Beach, FL at 7 P.M. For details call (904) 242-5938.
- Aug 9 Home Computers Users Group for Radio Shack TRS-80 meets at 7:30 PM. For details write or call TRS-80 Users Group Information of Eastern Massachusetts, c/o Miller, 61 Lake Shore Road, Natick, MA 01760, (617) 653-6136.
- Aug 9 Homebrew Computer Club meeting will begin at 7 P.M. in Menlo Park, CA at the Stanford Linear Accelerator Center Auditorium. Call (415) 967-6754 for more details.
- Aug 10 Mid America Computer Hobbyist meeting will be at 7:00 P.M. at Commercial Federal Savings & Loan, Bellevue NE. Intersection of Galvin Rd. and U.S. Hwy. 73-75. Write P.O. Box 13303, Omaha, NE 68113 for further information.
- Aug 10 Utah Computer Association will meet at Murray High School, Rm 154, 5440 S. State St., Salt Lake City, UT at 7 P.M. For details write or call Larry or Holly Barney, 1928 S. 2600 E., Salt Lake City, UT 84108. (801) 485-3476.
- Aug 10 The Rochester Area Microcomputer Society will meet at the RIT Campus, Rm. 1030, Bldg. 9 at 7:30 P.M. For details write RAMS, P.O. Box D, Rochester, NY 14609.
- Aug 10 North Florida Computer Society will meet at 227 Edison Dr., Pensacola, FL 32505. For details write this address or call Eugene Rhodes at (904) 453-3844.
- Aug 11 HAUCC will meet at 7:30 PM in Rm 117 of the Science & Research Bldg. of the main campus of the Univ. of Houston. For more details write or call P.O. Box 37201, Houston, TX 77036, (713) 661-6806.
- Aug 11 Northern New Jersey Amateur Computer Club (NNJACC) will hold its meeting at the Fairleigh Dickenson University, on the Rutherford Campus, Becton Hall, Room B8, at 7 P.M. For details write NNJACC, 593 New York Ave., Lyndhurst, NJ 07071.
- Aug 12 The Permian Basin Computer Group — Odessa Chapter meets at 1 P.M. in the Electronic Technology Bldg., Room 203 on the Odessa College campus. For details call (915) 332-9151.
- Aug 13 North Orange County Computer Club will have its meeting at Chapman College, Orange, CA. Doors open at 12:00. 105 Hashinger Hall Auditorium. Membership Chairman, Tracey Lerocker, (714) 998-8080 evenings. For more information write P.O. Box 3603, Orange, CA 92655.
- Aug 15 Rhode Island Computer Hobbyists (RICH) meets the at the Knight Campus of Rhode Island Junior College in the

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Aug 17 Madison Computer Society will meet at 7:30 P.M. at 2707 McDivitt Rd., Madison, WI 53713. Mike Shoh, president.

Aug 17 Sacramento Pet Workshop meets from 7-10 P.M. every third Thursday of the month. For more information contact David Howe, (916) 445-7926.

Aug 18 Long Island Computer Association meets at 7 PM at the New York Institute of Technology, Old Westbury Campus, Route 25A between Route 107 and Glen Cove Rd., Rm. 508. For more details write Long Island Computer Association, 36 Irene Lane East, Plainview, NY 11803.

Aug 18 Amateur Computer Group of New Jersey (ACGNJ) meets at UCTI, 1776 Raritan Rd., Scotch Plains, NJ 07076 at 7 P.M. For further information write to the club at the above address.

Aug 19 San Diego Computer Society will meet at the Grossmont Community College Student Center, 8800 Grossmont College Dr., El Cajon, CA. Doors open at 12:30. For details call (714) 565-1738.

Aug 19 The 7C's Committee (Affiliated with the Cleveland Digital Group) will meet at Cleveland State University Student Services Bldg., in the Kiva Room at 2:00 P.M. For more information write to Cleveland Digital Group, 8700 Harvard Ave., Cleveland, OH 44105.

Aug 19 Philadelphia Area Computer Society will meet at 2 PM at LaSalle College Science Bldg. at the corner of 20th & Olney Ave. For more details write PACS, P.O. Box 1954, Philadelphia, PA 19105.

Aug 19 Computer Hobbyist Group of North Texas will meet at UTA University Hall, Rm 108 at 1 PM in Arlington, TX. For details call Neil Ferguson at (817) 387-0612.

Aug 20 Central Florida Computer Club will meet at 2010 Fosgate Dr., Winter Park, FL 32789 2:00 PM. Contact Bill Kerns for details.

Aug 22 Sacramento Microcomputer Users Group, (SMUG), 7:30-9:30 P.M. at SMUD Training Bldg., on 59 St. Write Richard Lerseth, P.O. Box 161513 or call (916) 381-0335 after 5:00 P.M.

Aug 22 Okaloosa Computer Hobbyist Club will meet in the Santa Rosa Rm, in the Santa Rosa Mall, Mary Esther, FL at 7 P.M. For details call (904) 242-5938.

Aug 23 Diablo Professional Users

Group (DPUG) will meet at Diablo Valley College Library, near the Willow Pass exit of Fwy. 680, from 8-10 PM. For details write or call Bob Hendrickson, Electronics Dept., DVC, Pleasant Hill, CA 94523; (415) 687-8373.

Aug 23 Boston Computer Society will meet at the Commonwealth School, 151 Commonwealth Ave., Boston at 7 P.M. The school is located on the corner of Dartmouth St. in Boston's Back Bay. For information write or call the society at 17 Chestnut St., Boston, MA 02108, (617) 227-1399.

Aug 25 Alamo Computer Enthusiast meets at 7:30 PM in Rm 104 at Chapman Graduate Center at Trinity University, San Antonio, TX. For details call (512) 532-2340, or write to the club at 7517 Jonquill, San Antonio, TX 78233.

Aug 25 Washington Amateur Computer Society will meet at the Catholic University of America, St. Johns Hall, located at Michigan and Harewood Aves. in Washington, D.C. Contact Bill Stewart at (202) 722-0210 for club details between the hours of 10 A.M. and 12 P.M.

Aug 27 Summit City Computer Club will meet at the McMillen Library on the Indiana Institute of Technology Campus in Ft. Wayne, IN. For details write the club at P.O. Box 5096, Ft. Wayne, IN 46805.

Aug 27 Birmingham Microprocessor Group will meet at Southcentral Bell Company headquarters bldg. at 2 P.M. For further details write or call Jim Anderson, 2931 Balmoral Rd., Birmingham, AL 35223; (205) 897-9630.

Aug 29 Computer Amateurs of So. Jersey will hold its meeting at the National Park Municipal Bldg., 7 So. Grove Ave., National Park, NJ at 7:30 P.M. For details call (609) 541-1010, or (609) 541-8296.

Aug 30 Ventura County Computer Society will meet at Camarillo Public Library, 3100 Ponderosa Dr., Port Hueneme, CA 93041 at 7:30 P.M. For more information write: VCCS, P.O. Box 525, Port Hueneme, CA 93041.

Aug 31 Space Coast Microcomputer Club will meet at 7:30 PM at the Merritt Island Library, Merritt Is., FL. Contact Ray Lockwood at (305) 452-2159 for details.

Aug 31 Small Computer Engineering Association of Minnesota (SCEAM) will meet at the Resource Access Center, 3010 Fourth Ave. So., Minneapolis, MN 55408 at 7 P.M. For more information write to this address or call (612) 824-6406.

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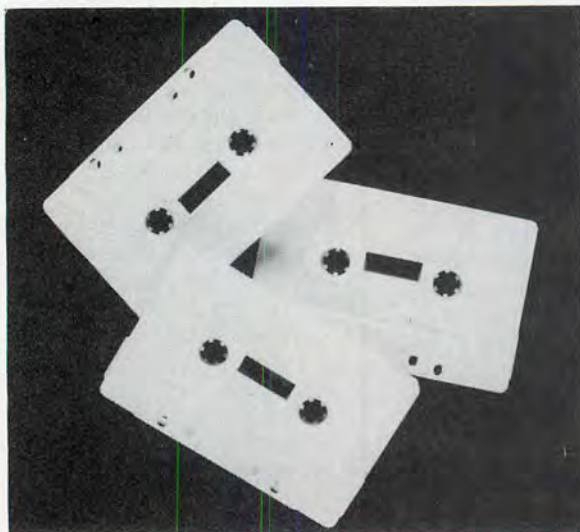
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WHITE COLLAR MICROCOMPUTER

By James S. White

SMALL COMPUTERS IN LARGE ORGANIZATIONS

Many present and potential applications for business microcomputers exist in large manufacturers, retail chains, and service organizations. Unfortunately, much of what is written and said tends to ignore these large-organization applications in favor of businesses characterized by the mom-and-pop grocery or the office of a single professional.

The potential for a wide variety of microcomputer applications in large organizations is even greater than their relative size indicates. Computers, of any size, give the greatest benefits when they do the same job repeatedly. Large organizations are characterized by large volumes of repetitive work done in specialization-of-effort functional locations.

These work-concentration centers are where microcomputers can be very valuable tools. Here, often, microcomputers can be used for long periods of time each day, thus multiplying their benefits. Operating costs can be relatively low because the repetition of work function allows a high degree of automation and minimal operator time and effort to change applications. Development costs can be relatively low, partly because a large-organization microcomputer is generally programmed to do only a few jobs.

The large computers now used in many large organizations aren't significant objective competition for microcomputers in many applications. True, these large computers and their large professional staffs have shown the way and justification for a wide variety of computer applications. However, under many conditions, the large computers are far behind their microcomputer cousins in service level and cost-effectiveness.

LOW COSTS AND HIGH PERFORMANCE

Several other factors give microcomputers in large organizations the capability to be tools which can be extremely cost-effective while giving results which are quicker or better than alternatives.

One factor is the low hardware cost of microcomputers. The monthly rental of many types of large computers is several times the purchase cost of common microcomputers. In properly selected applications, these microcomputers can produce equivalent results in the same or less time as large computers. Purchase costs of microcomputers, compared to their potential for savings in large organizations, are often so low as to be inconsequential. In many cases, microcomputer hardware costs less than the study necessary to determine if an application should be computerized, large computer style.

Microcomputer hardware maintenance costs are also low. The simplicity that keeps microcomputer production costs down also means that there are relatively few parts to malfunction. When problems do occur, replacing a large part of the microcomputer system often costs less in time and dollars than repair, by traditional methods, of either large or small computers. These savings will probably increase in the future, as labor costs increase and high volume, automated hardware production costs drop.

Personnel expense is a second category where using microcomputers can result in decreased costs and/or increased productivity. Some of these savings are expected, as it is generally understood that any kind of

computer in an appropriate application can cost less and/or do more than manually doing the same work.

Again, for some applications, microcomputers offer benefits in addition to those available from large computers. Many of these benefits result from the relative ease of planning and preparing to use a microcomputer for a specific application in a large organization.

In applications appropriate for microcomputers, frequently only one person needs to be involved in system planning and implementation. He or she recognizes an opportunity or need for improvement, identifies the problem and appropriate solution, and often plans, implements, and tests the correction. This on-the-spot person has no need to educate and otherwise communicate with several other people who are not familiar with his objectives and methods. Eliminated is the involvement of diverse types of people, involvement which is necessary in order to prepare large scale applications.

Administrative overhead costs frequently are also lower for microcomputers than for larger computers. When the microcomputer user makes a system change, he continues to be responsible for the same end results that he has been. Whether these results are increased sales, more accurate and prompt reports, or smoother production schedules, they are more easily recognized and related to ultimate business goals than is the performance of staff personnel. Separate administration, scheduling, and control of systems projects are not always required.

Programming expenses are another area with large potential savings, when a microcomputer is used. For reasons similar to those resulting in system definition savings, the ultimate user is often the best person to decide which techniques and shortcuts are best for his applications.

Motivation is another factor which cuts programming costs and results in a job well done. The end user is the one really interested in his problem being solved. This drive is combined with the fun of computing and programming, still alive for those who aren't working on the objectives of other people for eight hours per day. The resulting programming productivity often seems unbelievably high to those familiar with traditional techniques and measures, such as lines of code per day. Similarly, ongoing program maintenance costs for microcomputers can be much lower than for large computers. Changes in the relatively small and simple microcomputer programs can be made by the user who defines the problem.

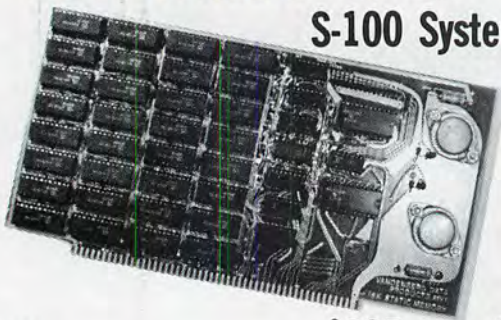
Testing is a final area where user controlled microcomputers are an advantageous tool in large organizations. The user is uniquely positioned and qualified to evaluate results, recognize problems, and take immediate corrective action, at least to the extent of not using invalid or questionable results. These actions and decisions generally result in cost savings, as well as a way to allocate programming time to the most important needs.

APPROPRIATE APPLICATIONS

Microcomputers are best suited for certain types of applications. Large organizations offer their own special opportunities, as well as restrictions. One major consideration in large organizations is that, for many applications,

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large computers are much better than microcomputers.

Independence is the key characteristic of one type of application appropriate for microcomputers. The microcomputer system should be able to do the entire job, without requiring help from other computer facilities. Computing power needs are one consideration, although microcomputers with more than adequate computing power are usually readily available.

Availability of appropriate peripherals is a determinant of whether a microcomputer is the best for a given application. For example, microcomputers are generally not ideal for applications requiring the processing of large volumes of 80 column cards. However, some applications require audio input or output or must control 110 volt devices. Today many such applications can be handled much better by microcomputers than by large computers.

In another type of application, microcomputers can themselves be used as terminals. In this role, a microcomputer is connected to a large computer, or another microcomputer, as a communications device. The microcomputer then becomes an intelligent terminal, very smart and user programmable. Because of its computing power, it can do much of the work that the larger, more expensive computer must do.

Another prime potential application area for microcomputers covers functions now done by programmable calculators. Advantages of microcomputers include better printing capabilities and more memory, including RAM, cassette, and disk. Especially promising applications in this category are those that need complex programming, or the entry of large amounts of data.

Microcomputers also function well as on-line controllers. In such applications, the microcomputer continually monitors, and gives instructions to, another device. The controlled device may be causing an end result, or may be generating data for use in computations. The microcomputer offers continuous supervision of the process, and the capability of storing or summarizing considerable amounts of data for review later by the operator.

Many other types of applications are more dependent on local considerations. Future development of microcomputer hardware will certainly allow an increasing number of applications to be handled by microcomputers.

SOME RESTRICTIONS

For many types of applications, a microcomputer is not the best tool. Consistent with public opinion, people can still do many jobs better. Also, there are many tasks which are handled better by large computers.

One commonly accepted problem in using microcomputers today is the lack of good application and system software. This lack of software is the determinant which prevents the use of microcomputers in many applications. However, software (both on a systems and application level) is being developed.

When deciding whether to use a microcomputer in an organization with large computer(s), the availability of computer and staff time must be considered. If open time is available, its true cost may be very low and the large computer an inexpensive way to perform a task. Often, however, time is severely constrained, and obtaining and paying for additional large computer resources may be much more difficult and expensive than utilizing a microcomputer.

Information is the life-blood of large organizations. The success or failure of a large organization increasingly depends on its ability to present timely, correct, and appropriate reports to the decision makers. The correct utilization of microcomputers may possibly solve the information gap in a timely fashion, but only if presented in a standard format. In a future column I will discuss information standards. □

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The Vector MZ includes: four MHz Z-80 CPU, two quad-density Micropolis mini-floppy disk drives, disk controller board, Bit Streamer I/O board with one serial and two

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Completely assembled and fully tested as a system, the Vector MZ is ready to go — just connect it to a terminal and optional printer and you'll have a complete microsystem.

That's why it makes good sense to see your local dealer and ask for Vector MZ. It also makes good sense to buy Vector MZ now at its low introductory price — \$3750.

Of all the leading microcomputer companies, Vector Graphic — and only Vector Graphic can make this offer. Nobody does it better.



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A Vector 2 microcomputer solves a lot of other problems too. Money problems for one. You can buy the Vector 2 for less than \$2000. And maintain it for next to nothing.

The Vector 2, in addition to the powerful Z-80 CPU, has a full 32K bytes of memory (expandable to 64K), a PROM/RAM board with extended monitor and a Flashwriter™ video board.

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Contact your local dealer today and ask to see the Vector 2. Never before has so much quality and value have been offered by Vector Graphic. Nobody does it better.

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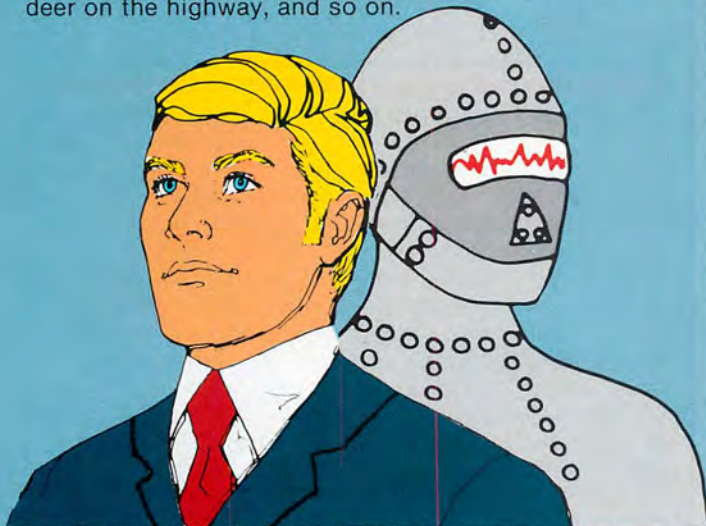
THE MIND REVOLUTION

By Merl Miller

How would you like to have a robot drive your car? The technology is available right now. If you could afford the equipment, you could install one tomorrow.

You would need three television cameras, some radar equipment and a computer. Your car would have to be equipped with cruise control and mechanical steering control. A camera would be installed on each front fender of your car. These outside cameras' sole function would be to recognize the lines on the highway. They would be directly interfaced to a pattern recognition program in the computer. (Actually, this is a fairly simple pattern recognition problem.)

The third camera would be installed in the center of the roof and would constantly scan for danger in front of you. Again, a pattern recognition program for this camera could be devised that would alert the CPU of deer on the highway, and so on.



Finally, you would need avoidance radar to tell you (and the computer) when you were getting too close to someone or when you had a tailgater. (Perhaps a "tail-gater eliminator" missile system could be installed.) The computer would also need a simple alarm system that would wake you up in dangerous situations.

This all may sound a little far-fetched, but it's not. It is very possible. The primary problem in developing this type of system is political. State legislatures will have to be convinced that it is safe. (This means a great deal of education.) The technology is certainly there. A more sophisticated system called TFR (Terrain Following Radar) is already in use in some military aircraft. TFR is an automatic-pilot system that is totally capable of flying an airplane. The pilot directs the system to maintain an altitude above the surface and the plane will maintain

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1234567890123456789012345678901234567890
1234567890123456789012345678901234567890
2X CHARACTER PATTERN
0000000000000000000000000000000000000000
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1X CHARACTER PATTERN
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UUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUUU
1234567890123456789012345678901234567890
ON THE TIMEOUT
PORTLY RELEASE
LUMP BACK SELFIES
1418-030670ED01021236CFL0H0ET
1418-030670ED01021236CFL0H0ET

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CIRCLE INQUIRY NO. 38

Although we cannot accurately forecast the future of AI research, we can get a feeling for where it is going by examining some of the basic questions, such as: What is natural intelligence? Can a machine be intelligent? How and to what extent can a machine simulate intelligence or display intelligent behavior? How can machines be described medically? What uses can be, or could be, made of intelligent machines?



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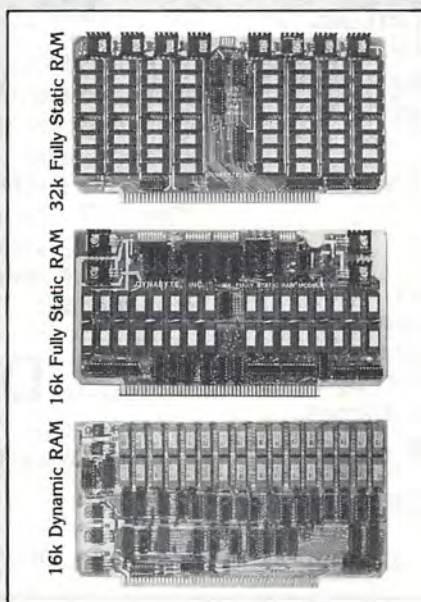
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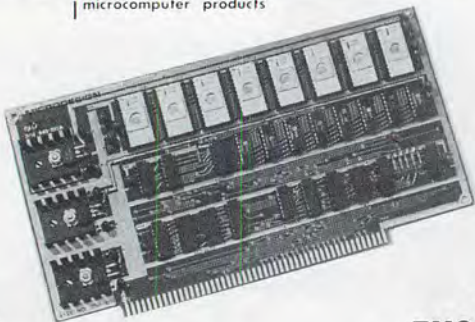
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CIRCLE INQUIRY NO. 35

The basic goal of AI research is to construct a machine that exhibits intelligence comparable to the intelligence of a human being. The machine does not have to do things in the same way a human does because no two humans do things the same way.

The classic test for determining whether a machine possesses intelligence on a human level is known as the Turing Test, named for Alan Turing, who pioneered research in intelligence. The experiment has never been seriously performed because no machine is yet capable of doing well on the test. The test consists of presenting a human being with a terminal which he can use to converse with two unknown sources. One of these sources is a human being, the other is a machine. The operator tries to guess which source is responding. If the correct source cannot be determined at least 50% of the time (and this result can be achieved using different human beings) then the machine is said to simulate human behavior.

An example might make this clearer. Let's assume that you set up two soundproof rooms. In one room you have one station consisting of a chair, desk and terminal. In the other room you have two stations. One station is a chair, desk and terminal. The other station is a computer. You sit in the first room and someone you don't know sits in the other room. The computer and the other person both select an identifier, such as A or B. Your job is to find out which one the computer is. If you stay with simple arithmetic problems, it will be quite difficult to determine which is which. It is only when you get into the abstract thought that you will be able to tell the difference; then it will be simple. But is abstract thought a true test of intelligence?

Next month we will look at some of the things that are wrong with the Turing Test and discuss why it will be some time before a machine passes it. □

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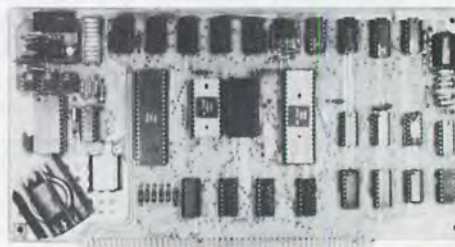
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MASTERCARD



JURISPRUDENT COMPUTERIST

By Elliott MacLennan
Attorney-at-Law

Stephen Murtha

This is the second of two columns dealing with using your business to its fullest potential as a tool to accomplish your financial objectives. The first dealt with the issue of non-deductible vs. deductible business expenses and group insurance. This column will deal with pension and profit-sharing plans, deferred compensation plans and communication of information to employees about their benefit plans.

There are a number of reasons why firms install pension and profit-sharing plans for their employees. The first is competition, as we mentioned in the first column. An adequate retirement program will help you attract as well as retain qualified employees. There comes a point in almost every person's working life when they begin to look at their retirement situation. If their personal savings and investments are not adequate, they will look closely at what kind of retirement program their employer has set up, if there is one at all. If it is not sufficient to meet their needs, they will usually go to work for some company that does have an adequate retirement program.

The second major reason why businesses install pension and profit-sharing plans is for the benefit of the owners of the business. The tax advantages of a pension or profit-sharing plan are tremendous. Once the business becomes profitable, a pension or profit-sharing plan can become one of the best methods of capital accumulation for an individual. As such, it certainly deserves close attention by the owners.

There are two major tax advantages to pension and profit-sharing plans or qualified retirement plans as they are often called (qualified by the IRS to receive this favorable tax treatment). The first advantage of these plans is that the contributions made to the plans are tax deductible as an ordinary and reasonable business expense by the business. In addition, the contribution is not reportable as income by the employee. The second advantage afforded these plans is that the interest and appreciation earned on plan assets are tax-free. When the contributions and interest are withdrawn from the plan at retirement, they are then taxed as ordinary income.

This double tax advantage can make a significant difference in the amount of capital which can be accumulated. A 35-year-old making \$50,000 per year would usually be in a 50% tax bracket. Let's assume he wished to invest \$5,000 per year and received an 8% return on the money invested. If he made that contribution in a qualified retirement plan, he would have \$566,416 at age 65. If he did his investing outside of a plan, he would only make a \$2,500 deposit after taxes and earn 4% after taxes. Under these circumstances he would have only accumulated \$140,212 in the same period of time, or \$426,204 less than in the qualified plan. This \$426,204 represents an unnecessary gift to Uncle Sam. As you can see from the above example, the difference between the results are tremendous and certainly not to be overlooked.

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CIRCLE INQUIRY NO. 1

One of the factors which keeps many businesses from adopting plans like this is the complexity of the plans brought on by ERISA (Employee Retirement Income Security Act or, as it is commonly referred to by specialists in the field, Every Ridiculous Idea Since Adam). While not to minimize the impact of compliance with ERISA on the desirability of a plan, there are many qualified professionals who work in this area who can minimize the hassles of ERISA. A word of warning is appropriate at this point. ERISA compliance work is a specialty. Although any attorney or CPA can technically provide this service for you, the results will typically be unsatisfactory unless you or your professional advisors use the services of a qualified specialist.

There are three general types of retirement plans which are acceptable under ERISA; the IRA (Individual Retirement Account), the Keogh or HR-10 plan and the corporate plans. An IRA is for employees who are not covered by a retirement plan at their place of employment. An individual may put 15% of their income up to \$1,500 per year into an IRA each year (\$1,750 if their spouse does not work outside of the home).

The second type of plan is called a Keogh or HR-10 plan, which is for unincorporated self-employed individuals. Under a Keogh plan, individuals can put a minimum of 15% of their adjusted gross income, up to \$7,500 per year, into a plan. The minimum contribution is \$750 per year or an amount equal to their adjusted gross income if it is less than \$750. Any plan which is set up must include all employees of a sole proprietorship or partnership. The usual rule is that a contribution must be made for all employees of an equal percentage of income as is made for the owners. For example, if a sole proprietor has an income of \$50,000 and two employees making \$12,000 each, and he makes a contribution to his Keogh plan of \$6,000, he must make a contribution of 12% for each employee or \$1,400 for each.

A plan of interest to many computer hobbyists is the new mini-Keogh. This type of plan was designed for individuals who are employees at one job, and have a side job. If an individual's adjusted gross income is less than \$15,000 per year, then he may put 100% of his self-employed income, up to \$750 per year, into a mini-Keogh plan. If his adjusted gross income is \$15,000 or more per year then he may put 15% of his self-employed income, up to \$750 per year, into a plan.

Both IRA and Keogh plans enjoy the tax advantages of corporate retirement plans. In addition to that, the requirements for installing and maintaining these plans are much simpler than those for corporate plans. The big drawback for the successful self-employed individual is the maximum contribution of \$7,500. It is for this reason that when a business becomes successful, incorporation is considered in order to take advantage of the greater flexibility and maximum contributions offered by corporate plans.

Corporations have three types of plans available to them. They are defined benefit pension plans, defined contribution pension plans, and profit-sharing plans. A defined benefit pension plan is one in which a specified retirement benefit is provided to the employees at retirement, such as 60% of the average compensation of their last three years of employment. The annual contribution made by the employer is based on actuarial calculations using the current age and income of the employees. This type of plan is not too common in small firms.

A much more common type of plan is the defined contribution plan in which the annual contribution is simply some specified percentage of each employee's salary. Under a plan like this, the actual retirement benefit is determined by how much capital has been accumulated in each individual's account and how much benefit that will buy.

The final type of corporate plan is the profit-sharing plan. Under a profit-sharing plan, the amount of the retirement benefit is determined by the amount of capital which is accumulated in each employee's account, just as in the defined contribution pension plan. The annual contribution is determined by a formula, which is based on corporate profits. Thus the contribution is larger in more profitable years, when the company can better afford to pay for this benefit.

There are many more details about qualified plans which go beyond the scope of this column, such as Social Security offsets, vesting requirements, participation requirements and so on. Those should be taken up with a professional qualified in this area if you feel a corporate plan may be appropriate for your firm.

One of the problems faced by the highly compensated executive (self-employed or not) in this country is the high taxes which accompany the income. Often deferral of income has advantages from a tax point of view. The selective use of deferred compensation agreements by corporations in one way to accomplish this objective. Under a typical deferred compensation plan, a portion of an executive's income is deferred until he has completed certain contractual obligations, such as remaining with the company for a specified number of years, being available for nominal consulting work when he retires, etc. The requirements may be as restrictive as is appropriate for the situation. Their purpose is mainly to avoid income being currently taxable as income to the executive. If the executive was 45 years old and earning \$100,000 per year, the corporation would give him the following benefits typically for completion of his contractual obligations. He would receive \$20,000 per year for 10 years if he became disabled or \$20,000 per year for 10 years to his survivors if he died prior to age 65 or \$20,000 per year for 10 commencing at age 65.

In order for this plan to work, the corporation would purchase a \$200,000 life insurance policy on the life of the executive to supply the benefits. The premium is not deductible. The corporation gets its deduction instead when the benefits are paid. The individual reports no income until the benefits are paid to him.

One of the biggest problems employers have with employee benefit packages lies in the area of communication. In a recent study done by a consulting firm, the average U.S. corporation spends an additional 34% of payroll above and beyond cash compensation, to pay for fringe benefits. Yet the employees of those same firms when asked to estimate the cost of their benefits, came up with a number equal to about 4% of payroll. Thus the money spent on employee benefits is currently very inefficient when compared to cash compensation where an employee perceives a dollar spent as a dollar spent.

Two relatively simple steps may be used to solve at least a portion of this problem. Summary descriptions of the benefit package will help. Even the most clear booklets from insurance companies tend to scare all but the most inquisitive employees out of becoming familiar with the company benefits. The second method is periodic reminders to employees of what they have in the way of benefits by the use of posters, pay stuffers, and so on. □

The material presented in this column is intended for the reader's general information. The authors request that the reader consult professional advisors prior to applying this material to his or her specific situation. Anyone seeking further information can contact the authors directly at:

*Elliott MacLennan, 2855 Mitchell Dr., Suite 130,
Walnut Creek, CA 94598*

*Stephen Murtha, 3 Altarinda Dr., Suite 304,
Orinda, CA 94563*

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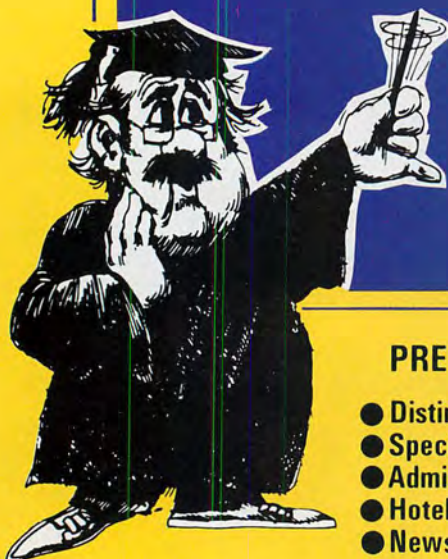
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- a) 7-hour tour of old Philadelphia and Valley Forge (daily, April 17-October 30)
- b) 7-hour tour of modern Philadelphia and Valley Forge (daily, April 17-October 30)
- c) Dinner at Old Original Bookbinders, one of the city's landmarks; includes soup, seafood entree, dessert, tip and tax (nightly)
- d) Penthouse dinner, with spectacular skyline view includes specially appetizer, choice of entree and dessert (excluding flambes), tip and tax (nightly)
- e) Dinner at Spats; includes choice of appetizer, entree and dessert, tax and tip (nightly except Sunday)
- f) Dinner at charming, medieval Monk's Inn; includes one drink, choice of appetizer, salad, entree, vegetable, beverage, dessert, one glass of wine, tip and tax (nightly)

Choice of TWO:

- a) 5-hour motorcoach tour of historic and modern Philadelphia (daily, year-round)
- b) Half-day tour to George Washington's encampment at Valley Forge and surrounding area (daily, April 17-October 30)
- c) Full day at Great Adventure entertainment park, includes admission to park and African safari (optional round-trip bus fare from Philadelphia not included); open 10 a.m. to 10 p.m., daily May-August, weekends only late April, September and October.
- d) Lunch at Spats Restaurant; includes choice of appetizer, entree and dessert, tip and tax (daily except Sunday).
- e) Dinner at Middle East restaurant; includes entertainment, choice of dinner menu, tip and tax (nightly)

Choice of ONE:

- a) 2½-hour tour of historic Philadelphia (daily, year-round)
- b) 2½-hour tour of modern Philadelphia (daily, year-round)
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*Broadway theater reservations should be made in advance. Because of constant changes in Broadway theater prices, a small surcharge may be necessary, in which case you will be advised at the time of confirmation.

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Boston Traveler's Information Kit

Dining certificate worth \$10.00 toward a meal at Anthony's Pier 4

Choice of THREE:

- a) 3-hour tour of greater Boston and Cambridge (daily, May 15-October 31; departs on the hour, 9 a.m. through 2 p.m.; Boston Tea Party Ship admission not included)
- b) 3-hour tour of Lexington and Concord (daily, 1:30 p.m., May 15-October 31; admissions not included)
- c) 7-hour tour of Boston, Cambridge, Lexington and Concord (May 15-October 31, daily, 9 a.m.; admission to Boston Tea Party Ship and luncheon not included)
- d) 4-hour tour to Quincy and Plymouth (May 15-October 18; Tuesday, Thursday, Sunday, 12:45 p.m.; admission to Quincy Mansion and Mayflower II not included)
- e) 8½-hour tour to Cape Cod and Hyannisport (May 15-October 31, Monday, Wednesday, Thursday, Friday, Saturday, 8:30 a.m., admissions and luncheon not included)
- f) 4-hour tour to Salem and Marblehead (May 15-October 15, Monday, Wednesday, Friday, Saturday, 12:30 p.m.; admission to Witch House not included)
- g) 10-hour tour to Martha's Vineyard (May 15-September 3, Tuesday through Saturday, 8:15 a.m., ferry boat fare included, luncheon not included)
- h) 6½-hour Rockport, Gloucester and Cape Ann evening tour (May 22-September 3, daily, 4:30 p.m.; September 4-October 14, daily, 3:30 p.m.; dinner not included)
- i) 8-hour tour along coast of Massachusetts, New Hampshire and Maine (May 15-September 24, Monday, Tuesday, Wednesday, Friday, Sunday, 9 a.m.; September 25-October 15, daily, 9 a.m.; luncheon not included)
- j) 8-hour tour to Newport, R.I. to see Gatsby-era mansions (June 11-September 3, Thursday & Sunday, 9 a.m.; admission to Vanderbilt's Marble House and luncheon not included)
- k) 10-hour New England tour to see the fall foliage (September 13-October 16, daily, 8:30 a.m.; luncheon not included)
- l) 8-hour tour to Old Sturbridge Village, a museum village of the early 19th century (May 15-October 22, daily, 10:30 a.m.; admission to village included; luncheon not included)

Choice of ONE Boston area admission:

- a) Boston Tea Party Ship and Museum
- b) Museum of Science
- c) Museum of Fine Arts
- d) Plymouth National Wax Museum
- e) Mayflower II replica of original Mayflower
- f) Plimoth Plantation
- g) Salem Witch Museum
- h) John Hancock Observatory
- i) Institute of Contemporary Art
- j) "The Whites of Their Eyes" Pavilion
- k) "Where's Boston?" Pavilion
- l) Prudential 52nd Floor Skywalk
- m) "USS Constitution" Museum
- n) Museum of Transportation
- o) Children's Museum

Choice of ONE:

- a) Dinner and dancing at Top of the Hub Restaurant (must be confirmed at time of booking)
- b) \$10 voucher, good toward orchestra tickets to pre-Broadway show, and regular tickets to Summer Theater performances, to the Boston Pops or to Red Sox home games (seasonal options for which dates must be checked and reservations made at time of booking)

Hotel tax

COST: From \$302/person sharing a room, additional night in Philadelphia is \$20.00/person and additional night in Boston is \$25.00/person

From \$404/person single room, additional night in Philadelphia is \$32.00/person and additional night in Boston is \$40.00/person

Three (3) persons sharing a room is even lower.

FROM THE FOUNTAINHEAD

By Adam Osborne

Despite my many warnings about mail order purchases of microcomputer systems, I have recently received a number of complaints about one of the more prominent manufacturers. I have made some investigations which indicate that two, now one, of the better known manufacturers could at any time go bankrupt. I am not going to name the companies in this column; if I do, that in itself is likely to force them into bankruptcy — which will do no one any good. Both companies still have time to put their houses in order. If you are a customer, however, once again be warned. If you pay in advance and buy from manufacturers through the mail, you are asking for trouble. End-users need a buffer between themselves and manufacturers, someone with enough clout to get some action when products are defective.

I have for some time believed that end-users should confine their business to computer stores, paying for goods only when the computer store can demonstrate that the product is ready and working as advertised. But to be fair, it is now many months since I have received any significant complaints concerning the better known, full-time mail order companies. My warning is against mail-order purchases made directly from hardware manufacturers. Better known companies who are primarily in the mail-order business — and I have named a number of them in previous columns — appear to be an honest lot. The few dishonest operators have gone out of business. I have no grounds for cautioning anyone against dealing with the legitimate mail-order businesses that have been around for some time. These companies are doing a good job, particularly servicing customers in remote areas that have no computer stores.

Jim Schreier, who produced the Schreier's Software Index, is now putting together an update. If you have software to sell or to give away, contact Jim. He may be reached at:

SSI

The Schreier Software Index
4327 East Grove Street
Phoenix, AZ 85040

Based on what I have seen, I believe that Jim is producing a unique product that will do a tremendous service to all microcomputer users. But to give him the best chance, he needs your inputs.

Bob Purser is doing the same thing as Jim — but for hardware. Bob has the most comprehensive index of S-100 boards that I have seen. Unfortunately, his index does not say anything about compatibilities

and incompatibilities, of which there are many among S-100 boards; nevertheless I believe his S-100 board index will be of interest to anyone who has an S-100 bus-based microcomputer system. Bob may be contacted at:

Bob Purser
P.O. Box 466
El Dorado, CA 95623

Bob, how about digging up some information on compatibilities and incompatibilities next time? People would pay a lot of money for accurate information in that area.

Bob Purser is also distributing software. Where Jim Schreier simply lists your software in his index, Bob will try and sell it, paying you a royalty.

There are some useful small business software packages appearing on the market. What is good about these packages is that they are very limited in their scope. I say that is good because it is easy for software to exceed hardware capabilities — and become useless.

Of course, only time will tell whether these new business systems have been adequately designed in terms of operator error recovery, audit trail, and simple flexibility. One of the better systems (for which I have seen documentation only) comes from Larry Grimes and Associates. If you wish to start doing a limited amount of data processing right away, you might contact Larry at:

The Computer Mart
633 West Katella Avenue
Orange, CA 92667

CompuMax, whose Micro Ledger I mentioned last month, claims that they will have payroll, accounts payable and accounts receivable ready by July. Again, these are limited systems, suited to today's limited microcomputer systems.

Another interesting product release that came my way was from Martin Rezmer. Martin has developed a time-shared disk BASIC system using the North Star floppy disk unit. Martin's system will support up to four independent users simultaneously. A capable microcomputer system with adequate floppy disk printer and terminals can now cost \$10,000. That is a price tag which is much easier to bear if four of you are sharing it. Martin can be reached at:

Byte Shop of Westminster
14300 Beach Blvd.
Westminster, CA 92683

Having looked at immediate problems and events, it would be interesting to speculate on the coming year.

I believe the most immediate and explosive growth will occur in the

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The ACT-I computer terminal manages a 1024 character display organized as 16 lines of 64 characters selected from the standard upper case ASCII set. Receipt of more than 64 characters on a line or the Line Feed code initiates a scroll operation.

STANDARD ACT-I FEATURES INCLUDE:

Switch selectable data rates of: 110, 300, 600, 1200, 2400, 4800, 9600, and 19200 Baud.

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- Standalone operation — absolutely no processor overhead required
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- Clear sharp video output signal (RS170 standard) capable of driving any CRT monitor

Price \$400. A cursor control/bell option is available for \$25.00.

ACT-II



We've added the convenience of an acoustically coupled modem to the economy and performance of the ACT-I to create the ACT-II. Designed to communicate either with remote processors through its modem, or with local computers via its RS232C or 20MA current-loop interfaces, the ACT-II offers versatility unheard of at its low price. The ACT-II (without monitor) slips easily into an attache case (4 x 14 x 11 inches) to commute with you between work and home.

The ACT-II's demodulator employs four stages of active filtering to minimize the bit error rate of the receiver. If you are eager to join the ranks of those who sit at home and enjoy the use of a powerful computer system across town, the ACT-II can be your "password".

As a further convenience feature, the modulator input and demodulator output are available at jacks on the rear of the ACT-II cabinet so that you may link a local serial device (such as a digital cassette tape or even your own computer system) to the remote computer through the internal modem.

The ACT-II can be purchased for only \$550.00

ACT-IV



If you're looking for a low priced high powered terminal, consider these features which are all standard with MICRO-TERM's ACT-IV:

DISPLAY: Upper and descending lower case characters, 24 lines of 80 characters, and auto-scrolling.

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EDITING: in PAGE mode, the user can insert or delete characters on any line and insert or delete lines on the page.

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The ACT-IVa comes in a compact (briefcase compatible) cabinet without video monitor for \$550.

The ACT-IVb comes complete with a 12" monitor and numeric keypad in a single enclosure for \$800.

Optional available features: separate printer port (110-9600 baud) \$50.

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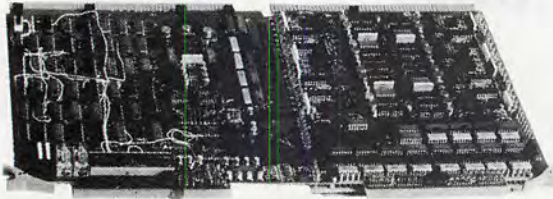
All MICRO-TERM products are fully assembled, tested and guaranteed for 90 days. The entire MICRO-TERM product line is available from stock at discriminating computer stores or may be purchased directly from the factory. All prices are less monitors (which start at \$130.00) F.O.B. St. Louis, Missouri.

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high-end microcomputer systems market. Certainly when we look at the success of Alpha Micro Systems, the message is loud and clear: the largest untapped market is at the high-end. This market will grow fast, now that good business software is beginning to appear. Good business software will also give owners of tiny microcomputer systems some incentive to expand into bigger systems. New powerful 16-bit microprocessors, such as the Fairchild 9440, the Intel 8086, and the Zilog Z8000, and equipment that will surround them, should give us high-end minicomputer performance at microcomputer prices by 1980. Most of this "high-end" customer base will be in small business systems.

But there is a whole different market that is being overlooked — and is possibly far more profitable for those who can get into it. I speak of hardware design. Those of you who would like to get rich (in addition to having fun) would do well to learn how to work with microprocessor hardware chips and signals. There are so many opportunities that it is easier to tell you what not to do. Don't bother with video games. That market is saturated. Don't bother with a new microcomputer system, a new intelligent terminal or a new microcomputer system peripheral. In fact, don't bother building a "look-alike" in any existing market. Go where microprocessors have never been before; with that you stand the best chance.

In my May column I discussed the disagreement Mr. William Burton had with the Structured Systems Group regarding availability of source code with purchased software. I sided with Structured Systems Group on the grounds that it is general business practice for software companies not to supply source code unless they specifically state that source code will be provided. I would like to reinforce this point. Anyone buying software should not expect to receive source code unless the terms of the purchase explicitly state that the source code will be provided.

I received a letter from Mr. Burton in response to my May column. Mr. Burton made a good point which needs to be clarified.

Mr. Burton notes that he had bought other software packages from the Structured Systems Group who previously provided source code. I was not aware of this fact. If a company makes a habit of providing source code, then suddenly stops, I believe they have a duty to inform all customers of their changed policy. They are, nevertheless, free to change their policy. I do not believe it is acceptable for a company to make such a significant policy change and expect their customers to discover the change with their next order — if that is, indeed, what occurred.

On a lighter note, the *Detroit Engineering*, in its March 1978 issue, has finally brought electronics to the layman. In case your friends have difficulty understanding "microseconds" and "nanoseconds," the *Detroit Engineer* obligingly gave some definitions for one part per million, one part per billion, etc. The one I like best is that one part per million is equivalent to one drop of vermouth in eighty 5ths of gin. (That explains a microsecond.) One part per billion is equivalent to one drop of vermouth in 500 barrels of gin. (That is one nanosecond.) Alternatively, one part per million is one minute in two years, and one part per billion is one second in 32 years.

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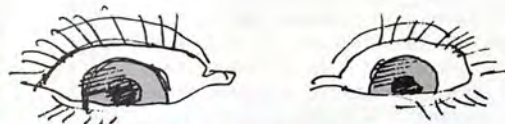


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EUROPEAN



INTERFACE

By Hans Drewitz and Roland Hesse

Prospecting is a relatively new discipline associated with the field of archeology. Its objective is to anticipate the location, extension and nature of a potential site prior to excavation. In order to process all the data which is necessarily accumulated with this method, microcomputers have been utilized to increase efficiency and speed.

A prospecting operation makes it possible to identify a site and conduct preliminary studies with a swiftness normally not associated with the conventional methods of site investigation. Using prospecting methods makes it possible to survey a large archeological area of up to several square miles or an area as small as a few square yards.

By utilizing the prospecting method and the power of a computer, it is possible to develop a reasonable work plan for site investigation. These are the methods employed by a research team from the University of Tours.

Investigations cover a number of prospecting methods which include the analysis of aerial electrical, electromagnetic, magnetic and stratigraphic data; the development of charts and maps based on the results of geophysical studies and the treatment of aerial photographs; and statistical analysis of chronological marks. The essential problem of all these operations is the processing and the storing of information. The number of parameters to be handled, especially for geophysical prospecting, is in the order of several ten-thousands (15 to 20 thousand for a small investigation, 100,000 for a medium-size investigation).

In order to accommodate these large numbers, a Wang 720C calculator connected to a modified Selectric typewriter is employed. This calculator with a core memory has the capacity to store 2K of instructions or 248 numbers of 12 digits. The data or the programs are stored on magnetic tape. The results of the prospective studies are entered manually and are also stored on magnetic tape.

The programs for mapping charts make use of the large number of symbols available on the special golf-ball of the IBM typewriter. The use of Greek characters and mathematical symbols makes it possible to obtain the simulation of shading. Every measurement corresponds to a point on the chart. The program calculates the shade of gray to be printed for every value.

Faced with an ever-increasing number of prospective studies, the system which has been briefly described (and which has worked satisfactorily for several years) is no longer able to handle the necessary requirements. Therefore a microcomputer system has now replaced the Wang as the research computer.

The Horizon microcomputer (based on the Zilog Z-80, with 32K of memory and two mini floppies) was chosen after considering cost and utility. Since the machine is S-100 bus it is possible to choose from several sources for additional add ons.

In archeological studies the importance of data bases is prime. Utilizing the programming capabilities and the disk operating system has made it possible to develop data bases geared to specific studies.

The rest of the system is comprised of a CRT and Selectric typewriter. The necessary geophysical data collection devices are also attached.

The computer handles the data input and the calculation necessary for presenting the data in some usable form such as a map. The system provides for the monitoring of mapping variations through the use of a graphics video board.

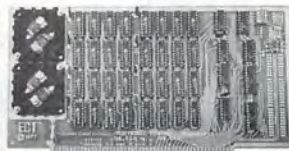
In archeological studies the importance of data bases is prime. Utilizing the programming capabilities and the disk operating system has made it possible to develop data bases geared to specific studies.

The advances in modern computer technology has made it possible to have big computer power on a small university budget. The time/cost relationship is now more in line since studies and the interpreting of data can be performed with greater speed. Larger sites can be investigated and research effort maximized, along with improved accuracy of the collected data.

The microcomputer has made it possible to reduce the time gap of the ages to just a few milliseconds. □



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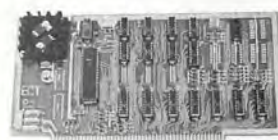
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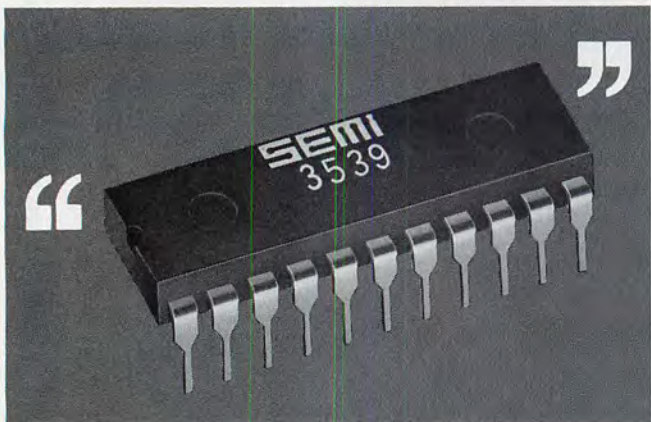
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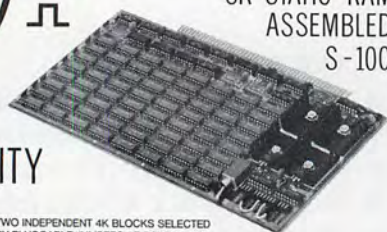
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CIRCLE INQUIRY NO. 42

Tandy Enters Small Business Market in Big Way

Introducing the Tandy 10

A little over a year ago when Radio Shack introduced the TRS 80 to the personal computing market, users were enamored with the little machine. Now Tandy Computers, a division of Tandy Corporation, is ready to do it again with the introduction of a low cost complete business system.



Dubbed the Tandy 10, the system is human engineered to make operation as easy as possible.

Priced under \$10,000 the system comes complete with a workstation that houses diskette drives and a video display unit. A matrix printer that operates at 60 characters per second is also included as part of the total system.

Although designed to be a stand alone business system, options can be purchased that make it an intelligent terminal for use with larger data computers.

The dual diskettes can hold up to 256,000 characters, which makes it possible to have immediate access to over 1/2 million characters of information.

To complete the system Tandy has provided extended BASIC, and provides, as an option, FORTRAN IV and Assembly level programming languages.

The system is really not just a business tool but a complete computer system. Users will find it easy to develop the necessary applications programs and routines required to do the necessary business tasks.

At this writing no information was available regarding canned applications. However, it is more than likely they will be made available to enhance the viability of the machine.

These applications will probably include the general business routines such as inventory control and general ledger packages. The system is flexible enough to utilize existing packages that can be purchased from software vendors or found within the pages of INTER-FACE AGE.

More information on this system can be obtained by writing directly to Tandy Computers, Department R22, P.O. Box 2932, Fort Worth, TX 76101, or calling (800) 433-1679.

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CIRCLE INQUIRY NO. 33

SENSE LINE

By Rich Kuzmack

President, Chesapeake Microcomputer Club, Inc.



Like so many computer clubs across the country, the Chesapeake Microcomputer Club (CMC) is a by-product of a visit by the MITS Mobile Computer Caravan. MITS came to the Washington, D.C. area in November, 1975, to present their Altair Short Course, and many who attended indicated an interest in forming a

computer club by signing a mailing list that was circulated. A few weeks later John Gilchrist engaged a meeting room at an area motel and sent out notices for the first meeting of the new club. The notices must have been copied, posted, and passed around because over a hundred people came, many from quite far away. In addition to an interesting program with several speakers, that first meeting included a business meeting. The consensus of the business meeting was that a committee be formed to arrange things so that there wouldn't be any more business meetings.

The committee met a week later at the home of Bob Kuhns, who chaired the meeting. With Hal Novick, patent attorney and legal guardian of a Mark-8 microcomputer, volunteering to serve as legal counsel, the decision was made to incorporate. The committee chose five incorporators to draft articles of incorporation and by-laws, and who would then invite everyone to join "their club" at the next meeting. Those who joined would get to vote for directors who would select the officers from among themselves and who would see to the business running of the club. The committee completed its work by designating a Program Coordinator and a Newsletter Editor, and by selecting a place to hold club meetings.

Three of the five incorporators showed up at the appointed time and place and, with the guidance of our legal counsel, word-smithed the required documents into shape. An important concept was added as the by-laws were put together. Recognizing that many potential members would find the trip to a central meeting place difficult, and wanting to provide a way for participation to be more convenient, the incorporators included a provision in the by-laws for chapters. A chapter was to be a small-to-medium group of club members in a local geographic area which would supplement general membership meetings with meetings locally. Those who couldn't get to the general meetings would still be able to get involved with other computer enthusiasts to exchange ideas, information and experiences.

HOW IT'S ALL WORKED OUT

The corporate structure initially adopted has generally worked pretty well at relieving members of the rou-

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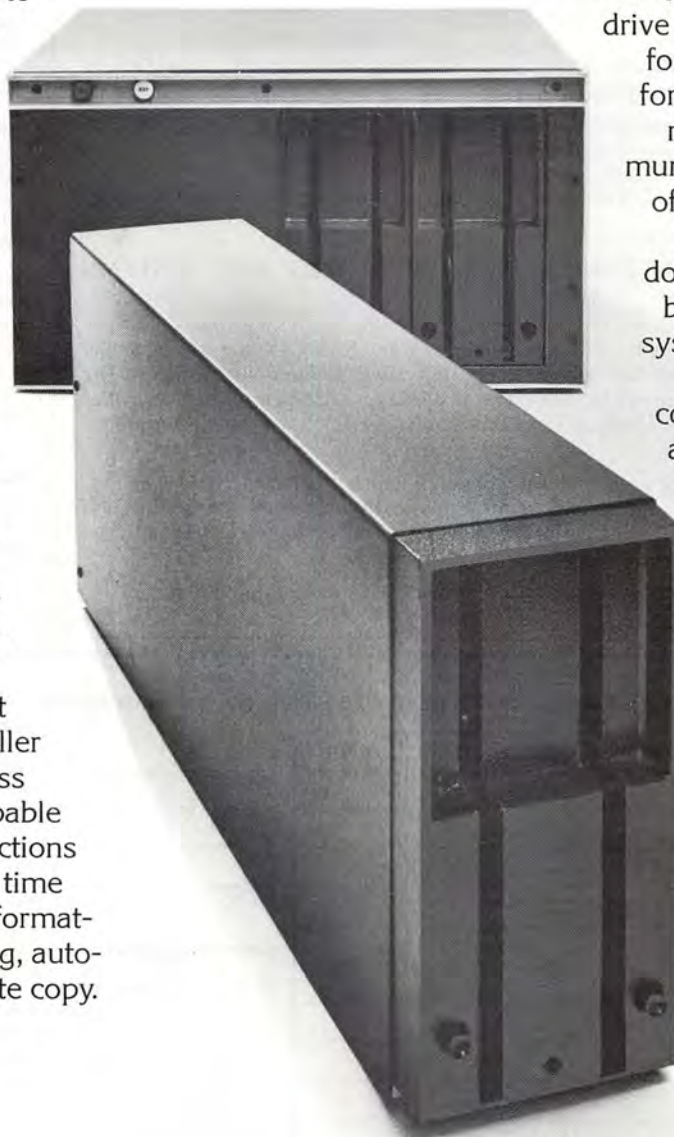
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3. **GENERAL LEDGER** — will follow A/P AND A/R, probably published in September.

Each book sells for \$15, and includes source listings in Wang BASIC, program and system documentation, and user's manual. Each is a complete package by itself, or all three may be implemented together to form a complete system with interdependent files.

And if Wang BASIC won't work, or you're not into programming, or you'd rather not key in thousands of words of source code*, take a look at the list of consultants who have adopted O&A programs, converted them to run on many popular systems, and are waiting to hear from you.

*Wang listings available from Osborne & Associates on cassette or hard disk. Contact O&A for information.

GOOD NEWS FOR CONSULTANTS, COMPUTER STORES AND SYSTEMS HOUSES

Osborne & Associates is converting its business systems from Wang BASIC — as it was originally published — to CP/M C-BASIC, which runs on most floppy disk-based microcomputer systems. The disks for each book sell for \$250. Once you buy the floppy disk you can copy it, resell it, change it or use it. We place no restriction on the magnetic surface; we copyright only the printed word in our books.

We will only sell the CP/M magnetic surface to consultants, computer stores and systems houses. Osborne & Associates prefers to write and sell books, not customize the programs or answer the end user's questions. PAYROLL should be available on CP/M in July — call us for exact availability and more policy information.

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tine chores associated with running the club, although member inputs are welcomed and, on an informal basis, actively sought. Essentially by default, the club is not a democracy; the club leadership, its officers and directors, make both housekeeping and major policy decisions, subject only to re-election on staggered two-year terms and a standard set of recall provisions in the by-laws. I have personally found the CMC membership willing to accept considered, positive leadership, and on that basis would suggest that the officers of other clubs lead rather than passively mirror a membership that may be starved for direction. Presenting a considered opinion on an issue will generally crystalize discussion pro and con, whereas just presenting the issue is likely to result in twice as many opinions as members. Responsible club leadership should help to focus things rather than encourage confusion.

The chapter concept has, on the whole, been quite successful. Several chapters were formed almost before the idea was announced, and the concept was expanded to include affiliates as well as chapters. The distinction is that an affiliate maintains a more independent identity, useful in situations of dual-affiliation and desirable for separate identity. Each chapter and affiliate has evolved somewhat differently. A couple have faded into extinction while new ones have formed in other areas. Our Richmond, Virginia, chapter grew into an independent computer club in its own right, while the Frederick, Maryland, chapter consists of a group of hams who meet to discuss their computer hobby on the air in a radio net.

Some people only come to the general membership meetings or to a chapter's meetings, although there are many who participate in several. Quite a few join a chapter or affiliate and not the CMC. Since the purpose of the club is to bring people with computers together, this has not been particularly troublesome, but it does confound attempts to quantify the number of people participating in the overall club structure.

Meeting formats and program content vary considerably, but usually include a generous random access period. General membership meetings usually have a formal speaker from outside the club, whereas one of the more successful chapters has one member at each meeting discuss and/or demonstrate a hardware or software project he's either just completed or is just getting into. Other chapters simply hold group discussions on some pre-announced topic. One sometimes gets the feeling that a key attraction of the meetings is simply the opportunity they provide to get together to socialize with others immersed in the joys and agonies of personal computing.

RELATED ACTIVITIES

The CMC has not considered it wise to sponsor a large personal computing show on its own, but has instead participated in or helped to organize personal computing activities at conferences and shows sponsored by other organizations.

In looking ahead, several of us in CMC are focusing our efforts toward next June in New York City, for I have accepted the task of chairing the NCC 79 Personal Computing Festival. Several members of the club have already volunteered to help out, but a solid, quality program depends on the participation of the people doing interesting things in personal computing. Now is the time for clubs and individuals that have done, or are doing, a neat application or project to begin thinking about showing it off to the rest of us by participating in the Festival next June. Most computer clubs have information exchange as one of their major functions, and the Festival is an opportunity to do it on a national scale. □

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HEART ATTACK:

How You Can Predict It and Some Things You Can Do About It

By Leo P. Biese, M.D., F.C.A.P.

Heart disease is the number one killer in the United States, and one form, the acute myocardial infarct, or "coronary," is the most frequent cause of sudden unexpected death. The facts are that by the age of 70 at least one out of every five readers of this magazine will be dead of a heart attack. Such loss of life is not "preordained" but is a consequence of the way we live. Many population groups in the so-called "Third World" do not have anywhere near the death rate from coronary heart disease that the affluent Western civilizations can look forward to.

In recent years, we have been accustomed to reading that eggs, butter, smoking, and all sorts of other things are bad for our hearts. Sometimes we are even given some sort of vague figures about how bad these things are for us. This program will calculate your risk of a heart attack, but far more importantly, it will show the improvement that can be achieved by reducing the factors over which you have some control.

BACKGROUND

For twenty-eight years the Heart and Lung Institute of the National Institutes of Health, U.S. Public Health Service, has been closely studying the population of Framingham, Massachusetts, in an effort to determine the incidence and factors that influence heart and vascular diseases of all types. From a massive program of multivariate regression analysis, seven factors have been isolated as clearly influencing the probability of heart disease. Numerous studies by other research groups in various parts of the country have substantiated the validity of this data applied to the general population of the U.S. as a whole.

An eighteen-year follow-up of the Framingham population was published by the U.S. Government Printing Office in 1974. Dr. Kammell of the Framingham Project and D. McGee of the Biometrics Research Branch, kindly provided copies of the statistical data and the latter eradicated a notable bug that crept into the program one night. Neither these researchers nor the National Insti-

tutes of Health is in any way responsible for the use to which the author has put this data.

The statistical base is only valid for the ages of 35-65 (45-65 for women) and the accuracy of the program outside these ages has not been determined. It will be noted that the author has "fudged" a bit on the lower age limits. The data, furthermore, applies only to those free of known heart disease at the time the program is run. A previous heart attack, for example, would make the program completely invalid. The data of HDL is further qualified below.

THE PROGRAM

The program is written in MITS 4.0 Disk BASIC and is largely self-explanatory. Formatting and console-switching program lines for the production of a professional report have largely been eliminated in the interest of brevity. Double precision arithmetic is declared in Line 380 and is redundant since the "@" appendage and the D-exponent also signify double precision arithmetic in the MITS format; they are retained only for clarity. The program takes only about two seconds to compute probability in this format and does not constitute a significant time delay. For clarity, the actual published NIH regression coefficients are shown in a Remark statement ('....') as well as the alternates for all heart and vascular diseases beginning in Line 760.

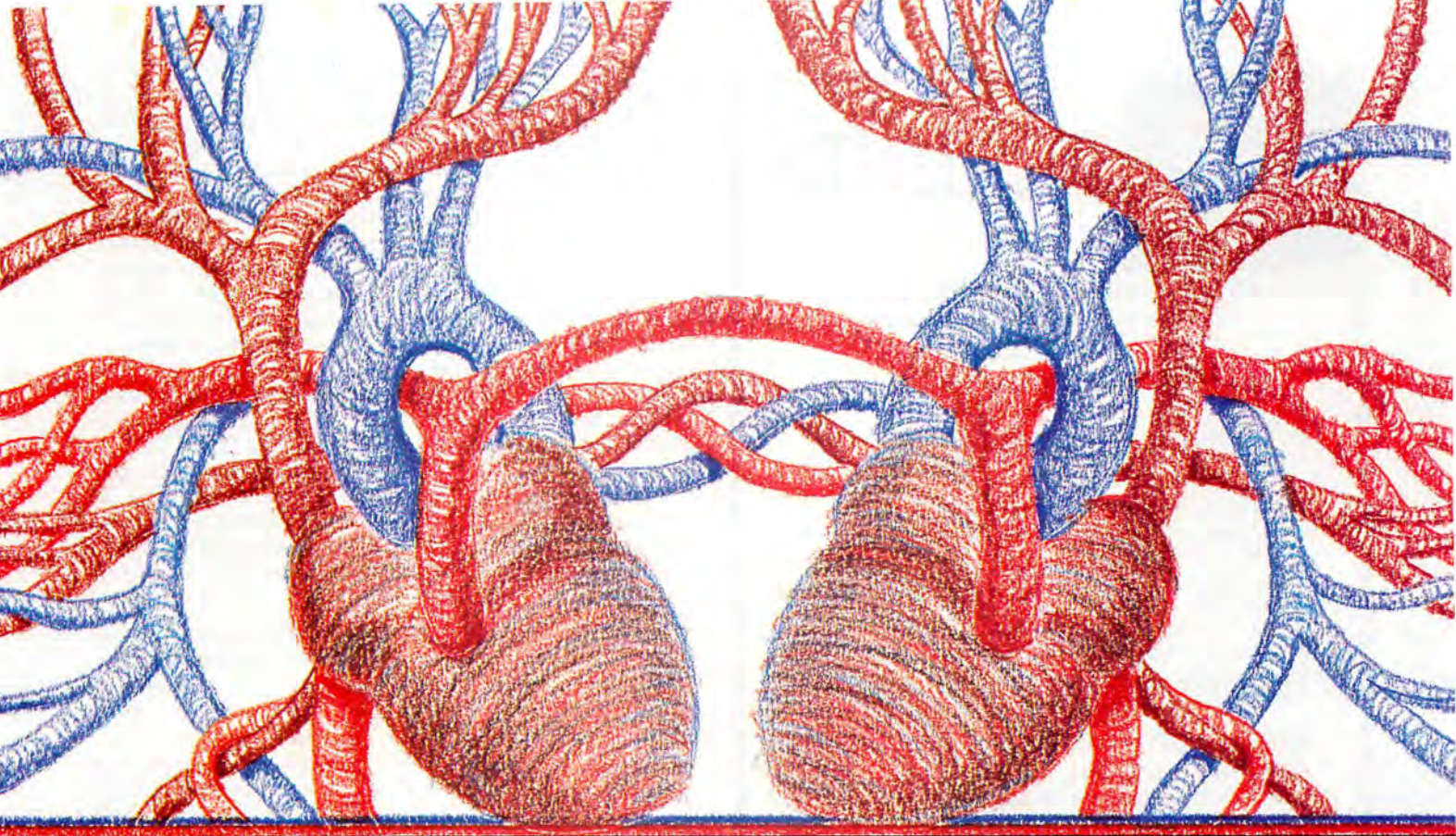
The only other problems that may occur in translating this program into other versions of BASIC are as follows:

In Line 1010 EXP(X) returns e to the power X. The formula for probability is:

$$P = \frac{1}{1 + e^{-\text{sum}}}$$

where sum is the total of all the coefficients times their multipliers plus the intercept.

Lines 1380 and 1400 have a PRINT USING statement to avoid printing out the fourteen-place double precision number. If your BASIC does not have this, an appropriate rounding procedure must be used. Finally, multi-



letter variables have been used for clarity and you may need to change these to single letters. The inputs have been assigned single letters so they can be recalled for the printout in their original form.

THE RISK FACTORS

Age is the single most important factor, since it is a high multiplier. Unfortunately, it — along with sex — is one that is not under our control. A2 is used as a correction factor for the non-linearity of age with risk, which is actually a quadratic term in the original equations.

Cholesterol is the value of your blood cholesterol in mg/100 ml, and can easily be obtained from your doctor if you don't already know it. The factor is correct for most modern automated and semi-automated laboratory methods, but your result may have to be lowered five to ten percent if an older, manual method was used. Ask your doctor to find out the comparison of his laboratory's value with the "ABELL-KENDAL" reference procedure if there is some doubt. Like age, cholesterol is a non-linear function and CXA is the correction factor for a cross-product term in the original equations.

BP is the resting systolic blood pressure. This is the higher of the two numbers you are usually given as "something over something," and is the peak pressure during the heart's contraction. (The other number is the diastolic pressure when the heart is relaxed.)

ECG refers primarily to evidence of left heart (the side that does most of the work) enlargement as shown on your electrocardiogram. Any other abnormalities in the ECG would also qualify, as would any other evidence of enlargement, such as an X-ray. Heart enlargement is an important indication that your heart may be working too hard pushing the blood around your body (a bigger pump for a bigger job) and as such is an important indicator of risk. It is, however, often a reversible change. This factor would not apply in the case of the physiological enlargement of a long distance runner or those who live on Mount Everest, but those fellows don't need to run this program!

CIG refers to the history of smoking regularly within

the past year. It is a one-time additive factor (0 or 1) to the risk rather than a multiplier. Note that the data is *not* available for increased risk based on how long or how much you smoke, just whether you do or don't. Strangely, the data on smoking in women gave a negative correlation, suggesting that they are better off (though only slightly) for it. This is believed to be an artifact of the population (it is not negative, for example, in the overall heart-vascular risk), but has been retained as given.

GLU refers to glucose intolerance as manifested by a "high blood sugar," sugar in the urine, or a known diagnosis of diabetes. Like smoking and ECG, it is a one-time additive factor rather than a multiplier. It is not known if correction of diabetes reduces the risk.

GLU and ECG are probably the factors which the reader may have the most difficulty in determining, though this information should be readily available from your doctor. If you do not know these, and set them to zero, the probability will be low (if you really did have them) by somewhere between three and ten percent for each factor, and you may want to run the program with various possibilities.

IN is in the X-intercept for the statistical data, the point at which all risk factors in the probability equation would be zero.

HDL, or High Density Lipoprotein, has been very much in the news recently as "the fat that's good for you." This protein and its associated cholesterol seem to protect the heart and indeed, very high levels (over 85) are associated with longevity, often occurring in families of people who customarily live to 90 or 100 without evidence of heart disease.

HDL was not part of the original Framingham criteria, but was from later studies on an older population and was based on an eight-year projection rather than a six-year one. For these reasons, it is not part of the "official" U.S. Government criteria. The figures appear, however, quite reliable. Unlike the other factors, it is a multiplier of the previously determined risk above. A value of 45 (55 in women) means that your overall risk is



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unchanged. Below this, the overall risk is multiplied up to approximately three times, depending upon the level. Values above this decrease your risk progressively. It is quite a new test, and if you have not had yours measured yet, a zero will bypass this part of the program. An exciting prospect is that it may be controllable in the near future. As of yet, however, only alcohol (and fish, to a very slight degree) have been shown to have any significant effect in raising your HDL. Alcohol does indeed raise HDL, but since cirrhosis is also a prominent cause of death, the reader is cautioned to wait until further research has clarified the prospects of controlling HDL before going off on a toot.

COM is your risk compared to the same age group (without regard to HDL), in which BP=105, CHO=185, and CIG, GLU, and ECG are all zero. This is the part of the program that will pointedly show you the decrease in risks that can be obtained by a little clean living. It was programmed as a simple table based on overall heart and vascular disease to avoid introducing seven more variables and repeating the calculations.

CONCLUSIONS

Put out the cigarette, switch to margarine, exercise a little, lose a little weight, and OFF THE KLINGONS for a good many years to come.!

PROGRAM LISTING

```

10 'HEART: PREDICTS THE PROBABILITY OF CORONARY HEART DISEASE WITHIN
20 '6 YEARS COMPARED TO A CONTROL POPULATION AND MAY BE RERUN TO SHOW
30 'A DECREASED RISK OBTAINABLE BY REDUCING THE 'CORRECTABLE' VARIABLES
40 'SMOKING, BLOOD PRESSURE AND CHOLESTEROL. COMPARISON IS TO A SAME AGE
50 'GROUP WITHOUT OTHER RISK FACTORS AND IS BASED ON THE DATA FROM THE
60 '281 YEAR ONGOING STUDY OF THE POPULATION OF FRAMINGHAM, MASS. BY THE
70 'NATIONAL INSTITUTES OF HEALTH AND PUBLISHED BY THE U.S. GOVERNMENT
80 'PRINTING OFFICE IN 1974. ADDITIONAL DATA ON THE HDL FACTOR IS FROM
90 'FROM LATER PUBLICATIONS AND CORRESPONDENCE (1977)
100 '
110 'PROGRAMED IN MITS 4.0 DISC BASIC BY:
120 ' LEO P. BIESE, MD, FACP
130 ' NEW ENGLAND CLINICAL LABORATORIES
140 ' 183 MAIN STREET
150 ' TILTON, N.H. (03276)
160 '
170 'LIST OF VARIABLES FOR RISK CORRELATION FACTORS:
180 '
190 'AGE IN YEARS, DIRECTLY CORRELATED FOR 35-74 ONLY
200 'A2 A CORRECTION FACTOR FOR THE NON-LINEARITY OF AGE
210 'CHO FASTING BLOOD CHOLESTEROL IN MG./100ML.
220 'BP MEAN SYSTOLIC RESTING BLOOD PRESSURE IN MM.HG.
230 'AVE TABLE OF MINIMAL RISK PROB FOR AGE GROUP
240 'COM COMPARISON WITH THE MINIMAL RISK GROUP
250 'SUM SUM OF THE INDIVIDUAL RISK COEFFICIENTS
260 'CIG SMOKING HISTORY (NON-SMOKER IS ONE ABSTAINING >1 YEAR); 0 OR 1
270 'ECG EVIDENCE OF LEFT HEART ENLARGEMENT IN THE ECG (0 OR 1)
280 'GLU GLUCOSE INTOLERANCE=1, NONE=0
290 'CXA CHOLESTEROL X AGE, A CORRECTION FACTOR FOR NON-LINEARITY
300 'IN THE REGRESSION ANALYSIS INTERCEPT
310 'HDL HIGH DENSITY LIPOPROTEIN LEVEL IN MG/100 ML
320 'SEX$ 'M' OR 'F'
330 'PROB THE PROBABILITY OF CORONARY DISEASE
340 'COM COMPARISON WITH THE MINIMAL RISK GROUP
350 'SUM SUM OF THE RISK COEFFICIENTS

360 DATA INPUT MODULE

370 PRINT:PRINT:PRINT:PRINT
380 DEFDBL A-Z
390 INPUT NAME 'IN$
400 INPUT SEX (M OR F) 'SEX$
410 INPUT AGE (IN YEARS) 'A
420 LINE INPUT DATE 'DAYS
430 INPUT DOCTOR/CLINIC 'DR$
440 INPUT CHOLESTEROL 'C
450 INPUT BLOOD PRESSURE 'B
460 INPUT ABNORMAL ECG (YES=1,NO=0) 'E
470 INPUT SMOKER (YES=1,NO=0) 'S
480 INPUT GLUCOSE INTOLERANCE (YES=1,NO=0) 'G
490 INPUT HDL 'HDL
500 '
510 IF SEX$ = 'F' THEN 630
520 AGE = A*.3754941# 0.3754941 MALES
530 A2 = A*A2 -2.2165D-03 0.0022165
540 CHO = C*.0271697# 0.0271697
550 BP = B*.0118041# 0.0118041
560 CIG = S*.4389169# 0.4389169
570 ECG = E*.5219694# 0.5219694
580 GLU = G*.2312953# 0.2312953
590 CXA = C*A2 -3.718D-04 0.0003718
600 IN = -19.4532586# 19.4532586
610 GOTO 870
620 '
630 AGE = A*.3769988# 0.3769988 FEMALES
640 A2 = A*A2 -2.325D-03 0.0023250
650 CHO = C*.0185534# 0.0185534
660 BP = B*.0132024# 0.0132024
670 CIG = S*.1779578# 0.1779578
680 ECG = E*.7187659# 0.7187659
690 GLU = G*.5602516# 0.5602516
700 CXA = C*A2 -2.288D-04 0.0002288
710 IN = -19.9537134# 19.9537134

720 '
730 ' THE ABOVE COEFFICIENTS ARE SPECIFIC FOR CORONARY HEART DISEASE.
740 ' FOR OVERALL RISK OF HEART DISEASE OF ANY KIND, INCLUDING STROKE,

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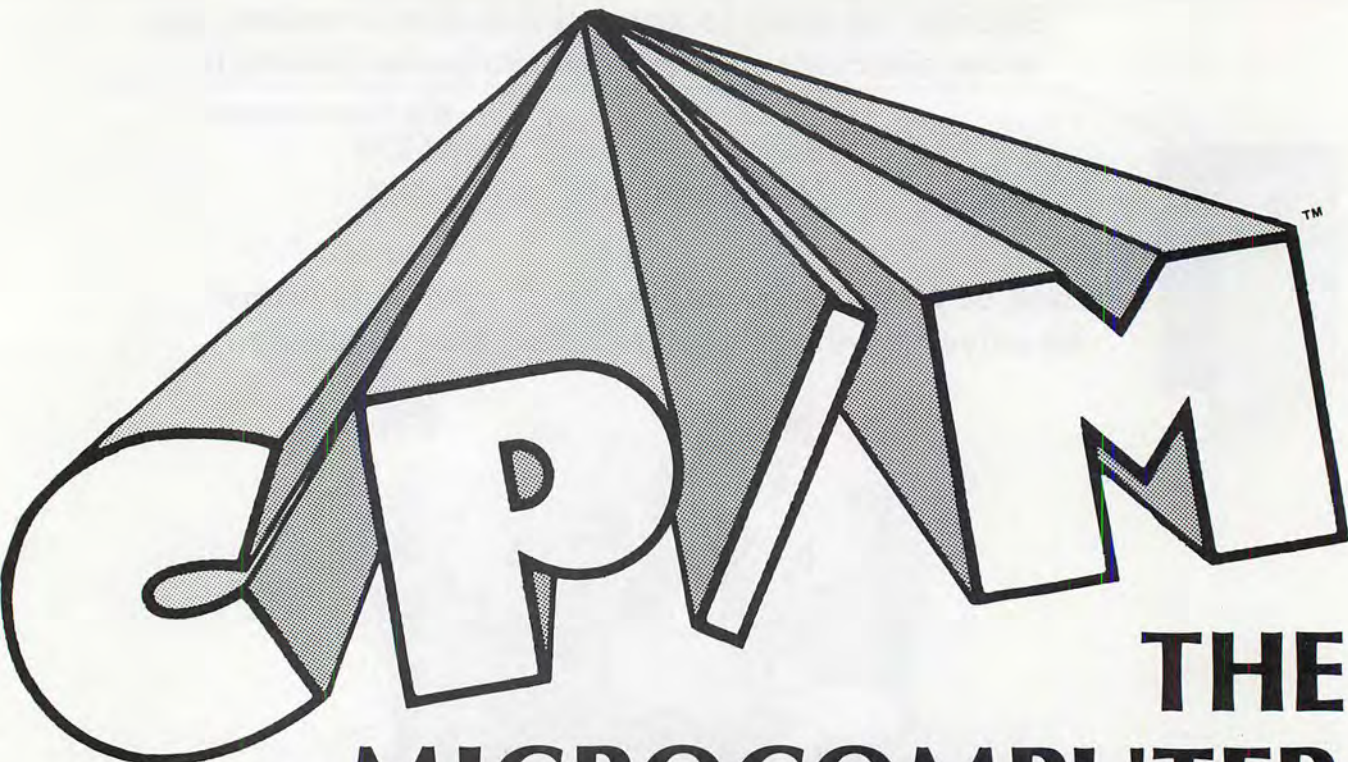
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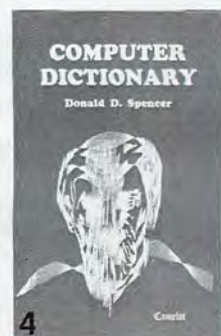
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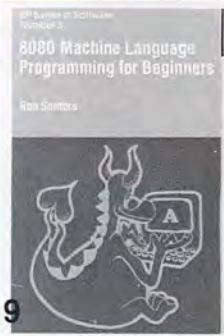
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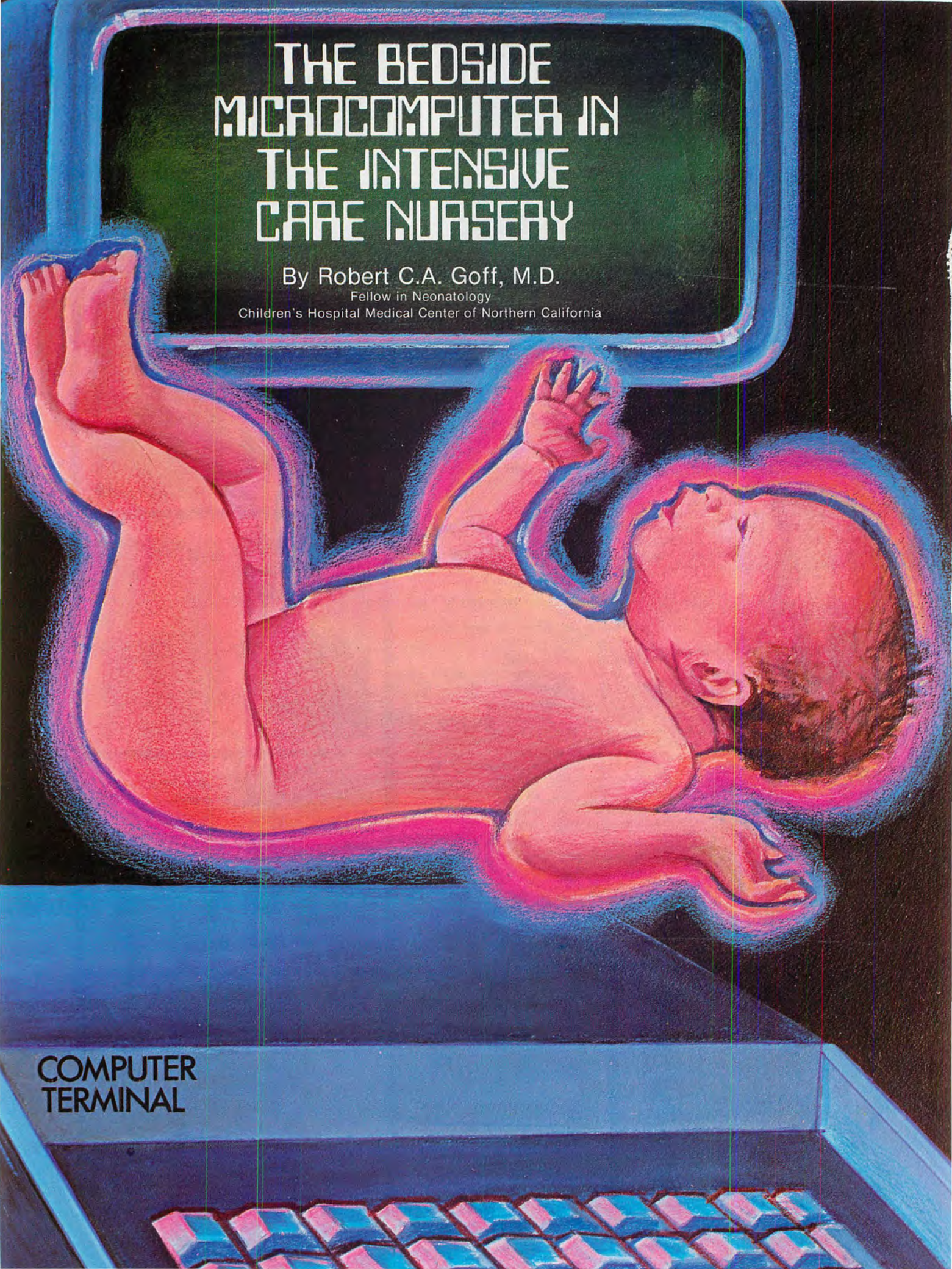
THE BEDSIDE MICROCOMPUTER IN THE INTENSIVE CARE NURSERY

By Robert C.A. Goff, M.D.

Fellow in Neonatology

Children's Hospital Medical Center of Northern California

COMPUTER
TERMINAL



ABSTRACT

Software is being developed to enable pediatricians and neonatologists to maintain bedside microcomputers in the Intensive Care Nursery, providing instant processing of, and access to the voluminous laboratory data and event summaries generated by each infant. The data is stored in a problem-oriented format, and may be accessed with an inquiry to any particular problem. The program is being written in North Star extended disk BASIC (version 6, release 3, — which utilizes random disk file access) and is implemented on a SOL/20 Terminal Computer with 48K RAM, and North Star Micro-disk drives.

INTRODUCTION

The use of computers in the Intensive Care Nursery is not a new idea, but I am unaware of previous attempts to use a microcomputer in such an application. This article will discuss the structure of the software, and the reasons for both the programming language used and the selection of the hardware configuration.

As a general background, one must realize first of all that infants in an Intensive Care Nursery (ICN) are usually highly unstable patients with multiple, complex medical problems, when compared to older patients in other hospital settings. Secondly, and as a result of this first consideration, infants in the ICN generate an overwhelming quantity of both data and narrative description of clinical events, conditions, and procedures. As an example, the daily progress note written in a typical patient's chart (in most areas of the hospital) will require perhaps 8 or 10 lines on one page of his chart, and will include all new laboratory results and procedures, as well as the patient's clinical condition for that day. In the ICN, however, it is not at all uncommon to find a progress note for one day requiring as many as 2 to 3 full pages of discussion and laboratory values. In addition to this voluminous daily documentation, there is at the bedside of each infant a flow chart of all the daily laboratory results and the daily computations of fluid intake, fluid intake per kilogram per day, calories per day, calories per kilogram per day, urine output per kilogram per hour, and so on.

While today, with no less than a Herculean effort, we are still capable of managing and reacting appropriately to the realms of information generated by our ICN patients (up to about 40 at full census), we are realizing that the current trend in Neonatology is toward more laboratory tests per infant and more documentation of the increasing number of procedures required by each infant. If this trend continues, then it will be virtually impossible to keep apace of this information deluge. Future trends aside, it is currently a major task, each time one of our infants is discharged from the hospital, to review his records (often consisting of three to eight volumes of hospital chart), understand his two to three month hospitalization, and then dictate a usefully concise and accurate summary. Our present practice is to dedicate one to three hours in preparing each summary, with our nursery requiring, on the average, two and a half summaries per day.

The solution to this problem is obvious — to utilize some form of computer processing and synthesis of both laboratory data and event description to maintain instant access to any past information, to accept daily input of data and, at the time of discharge, to abstract from the patient's file those pertinent items appropriate for inclusion in a discharge summary.

SOFTWARE

The program, written in North Star BASIC, is fairly simple in structure, but because of the multiplicity of types of data manipulations required and the extensive

text editing capability required of a narrative summary, the program length is projected to run to about 60K bytes, exclusive of the space needed for variable manipulation. As a result of its length, the program is structured in the form of disk files and BASIC sub-programs (stored on the disk), and is directed by an executive program which chains into RAM whichever sub-program is called. The program resides in one disk drive and stores all patient data on the other disk (a triple drive will enable the use of one microcomputer for every two infants). The organization of the sub-programs is a modified version of the Problem Oriented Format, now popular among physicians, and extensively used in Intensive Care Nurseries across the country. Rather than being oriented strictly to patient problems, the sub-programs are representative of body systems. This approach allows the formatting of virtually every type of clinical data or problem and will permit easy access, at a later date, to any particular information required by patient follow-up or retrospective data analysis.

. . .infants in the ICN generate an overwhelming quantity of both data and narrative description of clinical events, conditions, and procedures.

It should be noted that, because of the relatively stereotyped set of clinical problems common to premature and sick infants, an estimated 90 to 95% of all data and event summary information can be specifically encoded for later search and retrieval. The remaining 5 to 10% of the information would be accessible only by manually searching a category such as "OTHER", included under each body system. This situation is not the case with general medicine or, for that matter, general pediatrics, in which the multitude of commonly encountered clinical entities would require a much more complex structure of software in order to accomplish a comparable textual product with comparable data access capability.

Executive Routine

This is a short program which displays on the CRT a menu of the major sub-routines of the system. If the hardware consists of three disk drives for use on two different patients, then the patient is selected within the executive routine. At this point, the physician chooses the particular body system of interest and the executive chains in the sub-routine which has been called. With the sub-routine loaded, the physician is presented with a menu of routines included, such as:

1. Enter Data
2. Enter Events
3. Review Data and Events
4. Plot Data
5. Print Textual Summary
6. EXIT

On selecting, for example, HEMATOLOGY, the CRT displays a menu of events and laboratory tests related to that body system. When an event has been selected, the computer will then request the time and date of the event, and then compute the infant's age at the time of the event. This is now displayed for confirmation, and if approved, will be recorded in the appropriate file on the patient's disk. An opportunity is given to record additional events, then control is returned to the initial sub-program menu. On exiting the sub-program, the executive routine is chained into RAM, and it is then used to access further sub-programs.

Sub-routines

The major sub-routines serve to format the data and events into either random or serial disk files, whichever is most easily manipulated for the given type of information. The plotting functions are capable of producing graphs of data, plotted simultaneously with certain event markers, as well as standardized curves for reference. For example, the plot of the growth chart will, on a single page, plot three graphs: weight, length, and head circumference, each with appropriate standard percentile curves, and each in the format of the Babson growth chart. Because of the ease of generating these curves, and their usefulness to the physician who follows the infant after discharge from the ICN, they may be included in the final discharge summary and be available to the referring physician immediately. Additionally, attempts are being made to represent complex data, such as arterial blood gases and ventilator settings in easily interpretable graphic form.

Text

Most of the infant's admission history (primarily prenatal and maternal history) is encoded, and at the time of review decoded by the History sub-routine, so that most of this textual material is confined to the program disk and does not require space on the patient's disk. However, uncommon items of history can be typed in as text and are stored as strings on the patient's disk. This is also the case with each of the other sub-routines. The finished discharge summary is in the form of a standard textual discharge summary and may optionally be formatted as a letter.

An additional feature of the output capability of the software is that it can print the forms (presently filled out by hand) which are required by the State of California for each infant who is transported from a referring hospital to an Intensive Care Nursery.

Diagnoses

Each sub-program possesses considerable diagnostic capability. Any diagnoses which can be made solely on the basis of laboratory data and encoded events or encoded history will automatically appear in the summary as discharge diagnoses. While the attending physician has the option of deleting any of these diagnoses, or adding other diagnoses to the list, it is anticipated that by far the majority of diagnoses will be accurately made by the diagnostic algorithms, and will maximize future access for statistical study of patient care information. An additional feature of the diagnostic algorithms is that any suggestive (but not conclusive) diagnoses can be pointed out to the physician as possibilities which may warrant further clinical or laboratory investigation. (Once again, the rather circumscribed nature of Neonatology allows this capability to be implemented on so small a system.)

Choice of Programming Language

The languages considered in setting about this project were 8080 Assembly Language, FORTRAN, and BASIC (those currently available on the 8080 microcomputer). Assembly languages would allow for a much more concise program structure, considerably less RAM, and more rapid program execution. FORTRAN was eliminated because of the complexity of its string manipulation techniques in an application which extensively utilizes text manipulation. BASIC was chosen instead, for several reasons. Most importantly, it would allow the program to be quickly modified to run on just about any hardware system, including time-shared systems and the large systems available at most university hospitals. A second advantage to BASIC is that it would allow other users to easily modify any of the graphic,

textual, or diagnostic routines to meet their exact needs or preferences.

North Star extended disk BASIC (version 6, release 3) was chosen in particular, for a number of reasons. First, it is an extremely powerful and easy to use BASIC. Second, it possesses the CHAIN function needed for non-stop use of the multiple sub-programs. It allows complex string manipulation. It offers several instructions for calling any assembly language sub-routines which might be needed for future development of real-time vital sign analysis. Finally, this was a natural choice to use with the North Star disk driver as discussed below.

HARDWARE

The hardware chosen consists of a SOL/20 Terminal Computer with 48K bytes of RAM, at least two North Star Microdisk drives, a Sanyo CRT monitor, and a Diablo 1610-3 receive-only "daisy wheel" printer. If the system is to be used for one patient, or several, and disks are changed for each patient, a dual disk drive will suffice.

A network of microcomputers is certainly in the near future for most hospitals.) The one major criticism that I would level at the SOL's keyboard is a fault of the application rather than the machine itself.

The choice of the SOL/20 was based on two major factors. The first is size. The SOL will fit comfortably at the bedside in the ICN, whereas most other microcomputers are simply too bulky. The enormous backplane capacity of the larger units is not needed. If the 48K RAM is all on one high density memory board, and the North Star controller on another, then the SOL will have 3 empty slots for further hardware development. The second major factor in the choice of a SOL is its user-oriented keyboard and lack of a front panel. The optional numeric keypad is a tremendous advantage when entering large volumes of laboratory data. Perhaps a third consideration is the ease with which the SOL may be set in a "terminal mode" and networked to a laboratory minicomputer for direct data acquisition. (A network of microcomputers is certainly in the near future for most hospitals.) The one major criticism that I would level at the SOL's keyboard is a fault of the application rather than the machine itself. That is, an ideal keyboard for a direct patient care application would be a continuous-sheet neoprene keypad which would allow easy cleaning in an application which is directly involved in cleanliness and antisepsis. Hopefully, such a keypad will be made available for just such applications.

In considering the various disk drives available, again two factors were of greatest importance. First, once again, was size. The large disk drives simply require more room than is available presently at the bedsides of ICNs. The North Star drives can be tucked away just about anywhere. Second was flexibility in interchanging one patient's data at the time of his discharge, for that of another patient. A large disk would be wasted if it contained the information of only one patient, and flexibility would be lost if a large disk were used for more than one patient. The 90K byte capacity of the 5-inch

disk seemed to be only a slight overkill and could easily justify the use of one disk per patient.

The software was developed using a DECwriter as the hard copy output, and all graphics have been implemented so that any serial printer would be capable of generating entirely adequate graphs. Selecting a Diablo "daisy wheel" type printer was prompted by not only the desire for more precise graphics, but also the preference of most physicians for reading a solid type font rather than dot-matrix. The printer, whatever the type, is not intended to be at the bedside in the ICN. It should ultimately be a part of an additional system located in some other area of the nursery or nursery offices and would be used solely for printing the discharge summaries. This additional system can easily be cost justified by using it the remainder of the time for inventory, scheduling, accounting, and numerous other tasks. Alternatively, the printer may be placed on a mobile cart, and rolled to the bedside unit for use at the time of discharge.

COSTS

The system described, including the Diablo printer, should cost approximately \$8,500 with all necessary supplies and sales tax. Substituting a DECwriter for the Diablo 1610-3 will drop the cost by about \$1,200. To this must be added the cost of two diskettes per patient bed (one for current use, and one for a backup).

Justifying such an expense should be in the light of the cost of typical monitoring electronics used in the ICN. As an example, the PSI infant monitor (which monitors heart rate, respiratory rate, blood pressure, heart rate trend, respiratory trend, and blood pressure trend, along with appropriate alarms) runs in the neighborhood of \$10,000 per bed. Less expensive monitors are still in the \$4,000 range. By using one triple disk drive SOL system for every two beds, the cost is about \$2,200 per bed, plus the cost of one printer, spread over the entire nursery. These figures, of course, do not measure the improvement in patient care that would result from instant data access at the bedside, as well as increased physician time attending to matters other than a dictaphone. There is also a significant savings in medical transcription costs by eliminating the need to transcribe lengthy ICN discharge summaries. Perhaps the greatest cost justification for a large referral center, such as Children's Hospital in Oakland, is that by generating discharge summaries at the instant of discharge, the hospital will render better service to the referring physician, and certainly thereby improve community-hospital relations.

I should mention one final reservation that I have concerning this hardware configuration. For a small number of beds, such a system seems to be the most cost effective. However, as the number of beds increases, the investment in disk drives will far exceed the cost of hard disk memory and its development costs.

SUMMARY

A general description of a microcomputer implementation of a bedside computer for the Intensive Care Nursery is presented, with some of its basic features, and the author's justification for selecting North Star BASIC, and the SOL/20 North Star Disk combination. Costs and cost justifications are also discussed.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. Barry Phillips of Children's Hospital, Oakland, Peter Hollenbeck of the Byte Shop of Berkeley, Dr. Adam Osborne of Osborne and Associates, Adam Grossman of the Black Pine Circle School, Berkeley, and Bruce Bargmeier, Berkeley, for their assistance, suggestions, and encouragement in this project.

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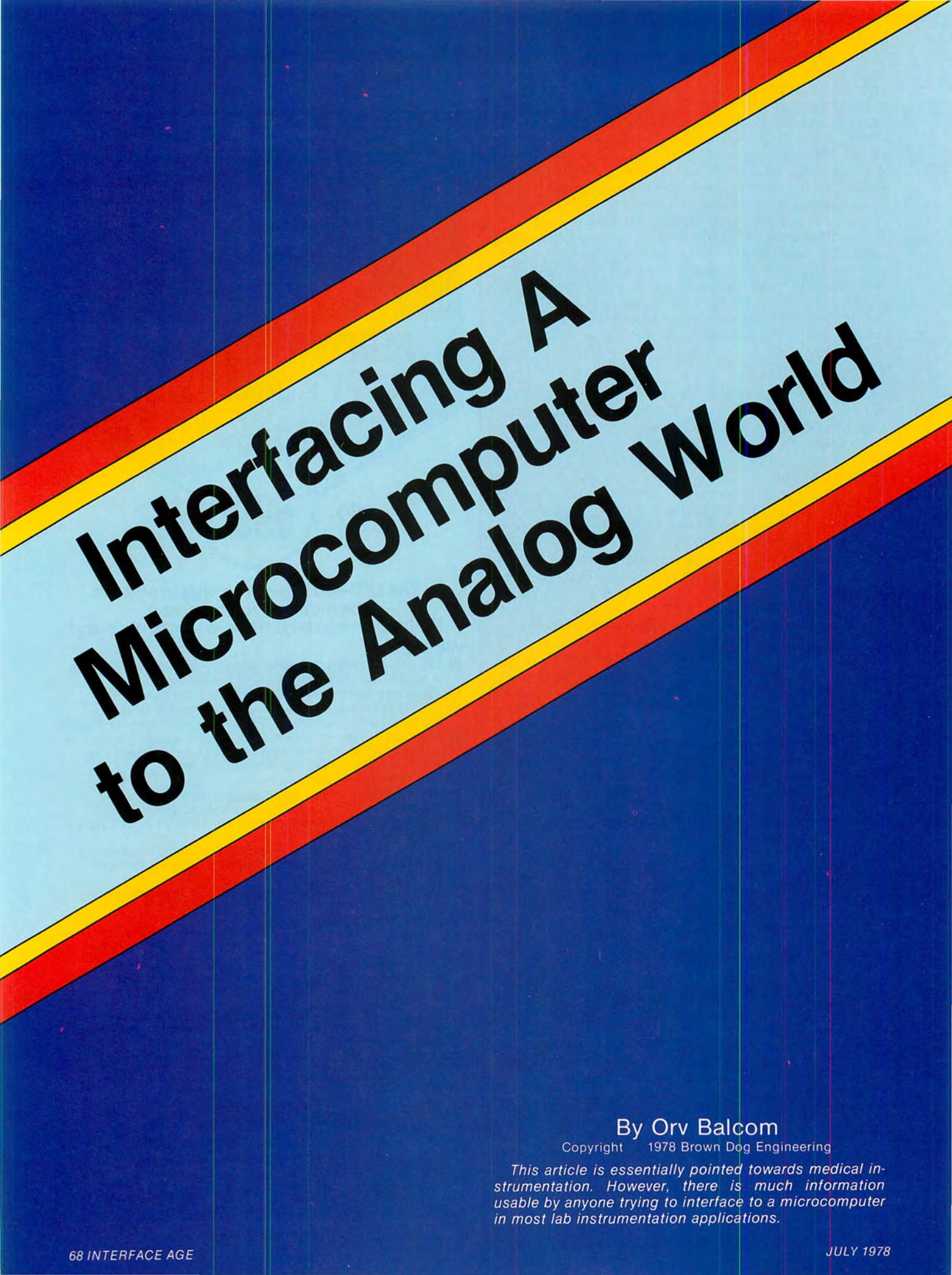
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Interfacing A Microcomputer to the Analog World

By Orv Balcom

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This article is essentially pointed towards medical instrumentation. However, there is much information usable by anyone trying to interface to a microcomputer in most lab instrumentation applications.

To start, I would like to make the following statement: I am not a doctor and I have no formal medical training. I've worked around doctors just long enough to learn a few words and become dangerous. I hope those of you of the medical profession who will read this article, will bear with me; especially with some of my essentially simple-minded explanations of very complicated physical phenomena. I have found it necessary to reduce everything to Kirchhoff's and Ohm's laws so that I can understand it. I would guess that many readers are the same.

NOTE, A MOST IMPORTANT POINT:

Electrical currents and the human body do not necessarily mix. It takes a very small amount of current, improperly applied, to seriously injure or kill a person. Therefore, extreme safety is always required, especially when contact is made to the body through low impedance electrodes. The actual amount of current through the heart required to induce fibrillation (which is a medical term for stopping the proper rhythm of the heart) can be less than 20 microamps. As little as 500 microamps of AC current at 60 cycles passing through the upper part of the body can also set up fibrillation. We all know that is not much current, and so it is very important that we not pass current through the body under any circumstances.

I would suggest that anyone attempting to actually monitor the electrical signals on a person only do so with the assistance of experienced, qualified help. Also, as an added precaution, all instrumentation to the subject should be isolated to a voltage of at least 1500V RMS minimum from power lines or ground and the leakage current between any patient connection and earth ground MUST be less than 10 microamps. No more than one ground connection should be made to the patient, since ground loop currents, even between the third line of electrical outlets in the same (improperly wired) room can exceed an amp. The safest approach, and the only one I recommend, is to use battery-powered pre-amplification with opto- or RF isolation to the remainder of the system.

MOTIVATION FOR ANALOG INTERFACING

The thrust of this article is interfacing the microprocessor to the real world, and specifically, interfacing it to a human body. Why would one want to do this? There are a couple of good reasons. Number one, it is often necessary to collect data about certain voltages that are generated by the body. This data is then stored and may also be used as computer input. A more efficient method would be to generate it as computer input directly. Usually the sequencing of the collection of the data can be handled by a microprocessor, such as in intensive care monitoring. Often, the data must be scanned and evaluated until certain criteria are met. Then alarms are set and the data is collected.

Real time control and data reduction is another reason for interfacing the microcomputer to the analog world which is not just medical in nature. The computer can control a variety of processes and also, through improved data processing, recover information which would not be observable on a scope or strip chart recorder. The essence of what I am saying is: if it is desired to obtain machine readable input from a physical process which has more than two states, some sort of analog interfacing will be required.

ANALOG INPUT/OUTPUT TO THE MICROPROCESSOR

The first requirement for connecting the computer to the analog world is the ability to input data to the computer and to output commands. By commands, I do not mean a simple relay closure, but a voltage that varies linearly or by any prescribed function of some parameter stored within the computer. I am going to start with the output device because, as you will see, inputting

data is sometime synthesized by outputting a *guesstimate* first and then deciding how close it is to the inputted data.

The basic output device is a digital to analog converter, or a D/A. A D/A consists of a resistor network (usually in a ladder form) and a set of switches. It may also include a voltage reference. There are one or two switches for each bit of output data. The network is excited by fixed (or variable) voltage and the switches are closed so that the output current from the D/A varies linearly as the binary number represented by the input data bits.

Most D/A are conductance devices. In other words, they provide an output current as a function of the input data word and the excitation voltage. The output is usually applied to an op-amp which acts as a buffer and converts the current into the output voltage. If a current output is desired, the op-amp isn't needed. The D/A becomes a multiplying D/A when the reference voltage can vary. The output is then proportional to the reference voltage times the binary value of the data bits. There are also what is called companding D/A's. These are D/A's which do not output a linear relationship to the data bits, but one that is more nearly a logarithmic relationship. These are used so that the resolution of the D/A will approximate a finite percentage of the actual output. This allows compression or expansion of a given signal and provides a higher resolution for small inputs.

The major inaccuracy in a D/A is due to resistor mismatch, either initially or over temperature. This can cause monotonicity error, which is when the binary input increases by one bit, but the analog output goes down (instead of up). This usually occurs at mid-range when all bits but the MSB have been on and they must be turned off and replaced by the MSB. The error in the MSB must be less than the value of the LSB or the output may not increase.

There are more D/A's available than can be mentioned in this article. Some of the more popular are from the 1408 or 1508 series, which are 8-bit D/A's and are available from Motorola, Signetics, Analog Devices and many others. These are monolithic, one chip D/A's providing a current output for a fixed input voltage and an 8-bit binary data word. There are also 10 and 12-bit D/A's manufactured by companies such as Precision Monolithics, Harris, and Datel.

The other side of the input/output coin is the analog to digital converter or A/D. A/D's come in three basic types, each with their advantages and disadvantages. It turns out that an A/D is not quite as simple as a D/A. In fact, two types of A/D's are really D/A's within a closed loop feedback system. In an A/D, conversion time becomes an important factor. The more bits that must be converted, the more time it takes; so for increased accuracy, time must be sacrificed.

One class of A/D converters is the successive approximation type, or SAR. In this A/D, a D/A converter of the desired number of bits resolution is connected to an up/down counter. The output current of the D/A is then compared (generally at the sum point of an op-amp) against the analog input signal which has also been converted to a current. The output of the op-amp is used to drive the counter either up or down until the D/A output is equivalent to the input. As the input signal changes, the op-amp controls the counter to track the signal with the output of the D/A. Assuming the loop tracks, the output of the D/A is then a faithful digital representation of the input analog signal.

Some units utilize a SAR chip which uses counting algorithm which is more like a binary search. The counter does not increment the LSB, one bit at a time, but instead starts with the MSB first. It is set, then the next

lower, etc. until the LSB. This makes for a very fast A/D converter. It should be obvious the conversion takes just a little more than 8 clock periods for an 8-bit unit. On a two megacycle clock system this means a conversion in a little over 4 microseconds to 8-bits resolution. But notice, as the number of bits goes up, the time for conversion slows down. Also, as mentioned above, it is difficult to obtain monotonic D/A converters as the resolution increases.

To solve these problems, enter the dual or triple slope A/D converter. The essence of this type of a converter is that a time varying signal is compared to the input signal. A clock is started at the beginning of the comparison and when the two signals are equal, the clock is stopped. The clock has been incrementing a counter from zero so now the value in the counter is proportional to the physical quantity being measured. Various schemes, such as dual and triple slope conversion, are used to cancel out component inaccuracies.

This type of a converter can provide good accuracy and excellent resolution up to $4\frac{1}{2}$ BCD digits at a relatively low cost, but at a sacrifice in speed. Remember, to convert $4\frac{1}{2}$ BCD digits, 20,000 counts of the clock are needed. Another advantage of this type of converter is that it has no monotonicity problems and is extremely linear. This is the converter used in most low cost DVM's and is available in many single and dual chip sets.

The above two descriptions have been concerned with general A/D techniques. The following technique is limited to an A/D which is interfaced with a computer. In this approach, a D/A is used to output an analog signal. This signal is then compared to the input signal using a comparator. The comparator then sends a signal to the computer saying whether the outputted signal was above or below the input. The computer must then correct the outputted signal to make it equal to the input.

The converter is similar to a successive approximation converter with the computer replacing the SAR hardware. It can be seen that the software in the loop becomes important in this system and the speed of the system can be highly software dependent. Also, if during the time taken for the conversion, the input signal can move more than one bit, it is necessary to have a sample and hold circuit or the software can get totally confused.

To summarize the above, a successive approximation D/A works best at lower resolutions such as 8-12 bits, but is relatively fast. The slope type A/D can provide accuracies to better than 1 part in 20,000 but is relatively slow. The software/comparator A/D has approximately the same accuracy as a successive approximation unit (since it is based on the D/A used), but its speed depends on the control software.

Some examples of available D/A's are as follows: The National MM-4357, is an 8-bit, successive approximation unit with a 40 microsecond conversion time. Also, AMD makes the 2502, which is the successive approximation register only. It needs a D/A to run with it, but it has a conversion time around 5 microseconds. Dual slope units include the ADC 3511, which is a $3\frac{1}{2}$ digit unit from National. Also, the MC-1443 which is a similar unit from Motorola. Teledyne has a $3\frac{1}{2}$ digit C-MOS unit, the 8700 series, which converts in 12 milliseconds and uses a charge balancing technique. Another very interesting chip is the MM74C915 from National. This device will convert 7-segment information to BCD, providing an interface to the many more DVM (and clock) chips.

ANALOG CONVERSION AND THE S-100 BUS

The above discussion may have been slightly involved, but it was a necessary basis for what follows. Those of us who have S-100 bus machines can jump right past the A/D, D/A hassle at the chip level since there are some very good S-100 bus boards available. My favorite (since I have

one), and also an extremely efficient board, dollar-wise, is the Cromemco D+ 7A I/O. This board is really magic in the Instrumentation Lab. It provides the following:

- 7 8-bit D/A's with sample and hold buffers.
- 7 buffered input A/D's which are multiplexed into a SAR A/D converter.
- ± 2.5 volt standard input/output range. Up to 10 volt unipolar/bipolar range selectable with circuit modifications.
- Conversion time of the system is 5.5 microseconds for A/D or D/A.
- Additional handy item: 1 8-bit parallel input port and 8-bit parallel output port. TTL levels.

I have done lots of little tricky things with this board, like using the A/D inputs to sense TTL levels or using the D/A to output TTL signals. With this approach, you can interface the parallel port plus generate any strobes or hand-shake signals using one or two of the converters and still have five left for handling analog data. I don't think it would take too much work to also interface it to the IEEE standard parallel bus using the 8-bit parallel in/out ports and a bi-directional bus driver chip controlled by one of the D/A's. This would allow interfacing to many commercially available pieces of test equipment. This would be handy if you wanted to keep a Pet.

MITS also has an A/D board — the 88 ADC. This is a high accuracy 12-bit A/D converter, with optional 8-port input multiplexer. It has a 50 microsecond conversion time. This board is thoroughly specified for accuracy and temperature effects and appears to be a laboratory quality A/D.

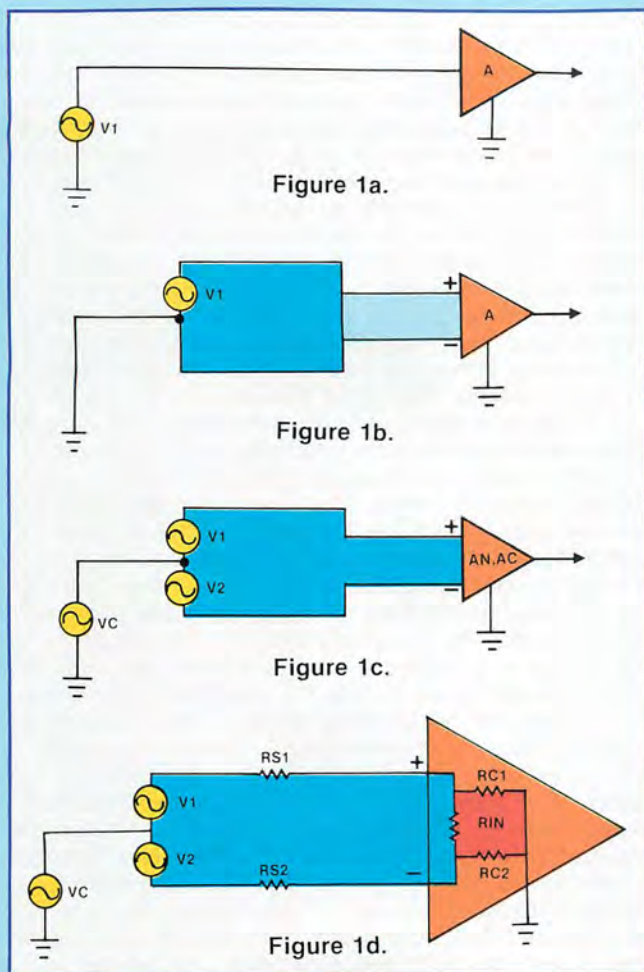
PolyMorphic has a third type of A/D converter board, their model ADA. It has an optional one or two channel, 10-bit A/D converter. It also has 8 comparators. With a comparator, one of the D/A's and the appropriate software, the user can generate a 10-bit A/D converter. This would give you a 10-bit A/D and 10-bit D/A on the same board.

AC SIGNALS

Now that we have analog signals out of our little micro and it can handle analog inputs, we need to try to tie it into the real world. Most A/D or D/A are scaled to ± 2.5 , ± 5 , or ± 10 volts. Real world signals usually show up in millivolts, sometimes even microvolts, or maybe even kilovolts. They need to be conditioned to the appropriate level for an A/D converter. Also, real world signals are usually combined with noise which must be excluded. Sometimes frequency compensation must also be added. In general, most signals can be reduced to a voltage. Whether they start out as a current or as a resistance, conversion can be accomplished with references, resistors and op-amps. The first signals we will consider are AC signals.

The basic conditioner is a buffer amplifier, as shown in Figure 1a. This is a simple AC amplifier which has the properties of a gain called A for a given frequency band. The frequency response of the amplifier should be such that the gain remains sufficiently constant over the band of interest. In all cases we will assume the A/D converter is already taking care of the sample and hold function (if required) so that additional errors are not introduced because the signal is changing.

Differential amplifiers are generally used for instrumentation applications. In other words, they amplify the difference of signals applied to the amplifier's plus and minus inputs. Figure 1b depicts an amplifier of this type. The output is equal to the gain, A times the difference between the plus and minus inputs. In this case, the output would be equal to A times V_1 . The significance of the minus input is that if the signal had been applied to the minus input instead of the plus input the output would have been 180 degrees out of phase from the in-



put. In other words, for a sine wave input, when the input was going positive, the output would go negative if the input were applied to the negative amplifier input.

Now consider Figure 1c. Here we are getting a little bit closer to real life. There are two signals, V_1 and V_2 , which are assumed to be equal and out of phase. The combination of V_1 minus V_2 equals the input signal. This is called a balanced input and is kind of like the output from a center tapped power transformer. There is a third signal, V_3 . This is called the common mode signal. This is the signal that occurs between the reference point of the signal source and the ground of our signal conditioner. This signal can be caused from a variety of sources. For one, voltage differences between the third wire ground of a piece of test equipment and the micro-computer. Second, if the signals are being generated a long ways from the signal conditioner, it can be caused by pick-up in the cable shield or return lead. In any event, it is an undesirable signal. We see the amplifier has two gain terms, AN and AC . This is because a properly designed differential amplifier has much less gain for common mode signals, such as V_C , than it does for the normal mode signals such as V_1 and V_2 . The output of the amplifier shown in Figure 1c will be:

$$V_{out} = AN \cdot (V_1 - V_2) + AC \cdot V_C$$

Remember V_1 and V_2 are out of phase so they will actually add to provide the output. The common mode rejection (CMR) is a measure of the ability of the amplifier to discriminate between the desired signal and the common mode signal and is usually expressed in db. It is given by:

$$CMR = 20 \cdot \log(AN/AC)$$

Now look at Figure 1d. In the above examples we have assumed the amplifiers had infinite input impedance and the driving generators had zero source impedance. Figure 1d approaches the actual situation. Here I have

added source resistance RS_1 and RS_2 , as well as normal mode input impedance RIN and common mode input impedances RC_1 and RC_2 . If RS_1 equals RS_2 , and if the internal impedances RC_1 and RC_2 are much greater than RS_1 and RS_2 , we have not degraded the situation appreciably. But, in actual practice the following inequalities usually hold: RS_1 and RS_2 are much less than RIN which is less than RC_1 or RC_2 . This is because, by design in a good differential amplifier, the common mode input impedance is very high. RS_1 and RS_2 are much smaller than RIN or RC_1 and RC_2 but only in a relative sense. They are often not more than a 1000 times smaller than RIN . Also, they maybe less than 10,000 times smaller than RC_1 or RC_2 . In most bio-medical applications, RS_1 and RS_2 are never equal. For body voltage measurements, RS_1 and RS_2 are generally caused by the contact resistance of the electrodes to the subject under test, as well as some effects of the bulk impedance of the body. Therefore, they are very difficult to control.

The problem that exists is that these impedances, by divider action, will generate a normal mode voltage from a common mode voltage. Here is how it is done. RS_1 and RC_1 form a divider, as do RS_2 and RC_2 . The problem is that even if the loading of RC_1 and RC_2 may be small, say 0.1%, due to the differences in RS_1 and RS_2 , it is not exactly equal. If the dividers differ by 0.1%, they will create a normal mode signal equal to 0.1% of the common mode input. This will limit the CMR to:

$$CMR_{max} = 20 \cdot \log(1/0.001) = 60\text{db}$$

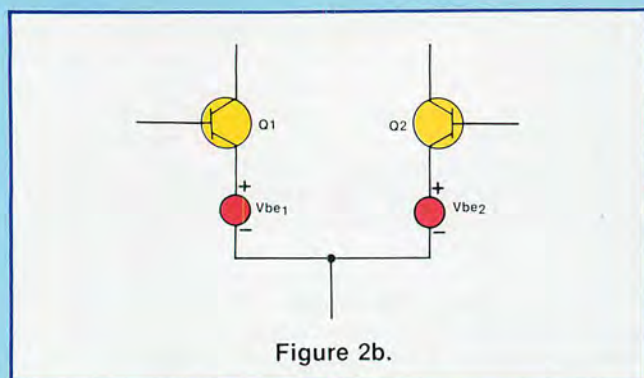
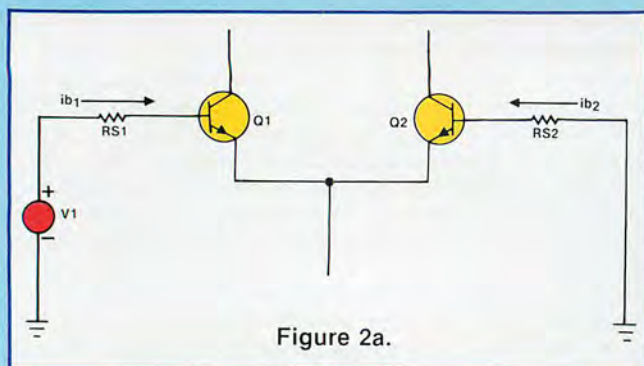
This CMR is marginal for most applications and unsatisfactory for many. What has been shown is that if the source impedance is not constant, the common mode input impedance must be greater than the largest expected difference in source impedance by at least the desired CMR.

I should also mention that RC_1 and RC_2 are not necessarily totally resistive. They can also be reactive. The biggest culprit is capacitance, and often just capacitance caused by circuit traces on the board. Consider that 10 picofarads of capacitance at 60 cycles equals 300 megohms. This seems like a lot, but with 30K electrode impedance, the CMR couldn't exceed 80db. With 80db, a 1 volt 60Hz common mode signal would produce a 100 microvolt normal mode signal which is in the range of many of the desired inputs. Obviously, if high CMR is desired, buffers must be placed very close to the electrodes with a minimum amount of shielded cable between the electrode and the input to the buffer. If not, the capacitance of the shielded cable combined with the source impedance of the electrodes can seriously degrade the CMR.

One last quantity to worry about in AC systems is linearity. Linearity means how close a plot of the input versus the output follows a straight line. Non-linearity will introduce distortion and distortion adds additional harmonically related frequencies to the input signal. Depending on what will or will not be done with the signal later, this can be important. For example, if through the computer program or through frequency compensation, high frequency signals are boosted, then harmonics generated in the amplifier will be more evident.

DC SIGNALS

Wide band DC amplifiers generally have all the problems of AC amplifiers but add some new problems of their own. If the required frequency response is limited, many problems in DC amplifiers can be resolved by filtering before amplification. Filtering after amplification can be dangerous in high AC noise environments, since the amplifier may become nonlinear on the noise peaks and generate a DC error. Two problem areas in DC amplifiers cause a shift in the output for a zero input. Since inside



an integrated circuit there are still transistors, I will use pictures of transistors to depict the problems.

Consider Figure 2a. This is an input stage to a typical differential amplifier. Two currents ib_1 and ib_2 are shown flowing into the base of the transistors (if they were PNP's, the current would flow out). These are the input bias currents and are the currents that are necessary to turn on the bipolar transistor. Every bipolar transistor requires some current even though it can sometimes be very small, i.e. in picoamps. If V_1 is a perfect DC input signal, then the input to amplifier Q1 is equal to $V_1 - ib_1 \cdot RS_1$. The input to amplifier Q2 is $-ib_2 \cdot RS_2$. If the currents are equal and the source resistances are equal, this will cause no problem. That also is the crux of the solution. It is necessary to attempt to maintain the bias currents as nearly equal as possible and the source resistances as small and as nearly equal as possible. This can't always be done. If RS_1 is fixed (determined by the signal source), RS_2 is generally a resistor which is added to match RS_1 . It is necessary to pick an op-amp with sufficiently small bias currents so that over the temperature range, the change in bias current will not cause excessive voltage differences to be generated across the source of resistances. I should mention that if FET input op-amps are used, the input current is generally so small that it is not a problem.

Now consider Figure 2b. In this case, we have a situation of perfect transistors Q1 and Q2 with voltage sources equal to their base to emitter voltages shown in series with the emitters. Again, in real life, these voltages are not equal. Any difference between the two, either at a static condition or over temperature will look like an input signal. For example, if the spec sheet says the input drift is 2 microvolts per degree C, this means there is an unknown and uncompensatable drift that can vary as much as 50 microvolts for every 25 degrees C that the case of the op-amp is changed. This input error, by the way, is also seen in FET input op-amps. In fact, it is sometimes worse in an FET op-amp than in a bipolar op-amp.

NOISE

The next item to consider in low level signal conditioning is noise. Noise can come from a variety of sources. Thermal noise is inherent in any resistor, but if

the signal source resistance is kept below 50K, it is generally not a problem in bio-medical instrumentation. Not that it can be ignored. I remember the first time I tried to measure a 50 microvolt signal using an inverting op-amp with a 1 meg input resistor. Lots of noise! It is always best to use a non-inverting amplifier for the first stage to minimize the source resistance the amplifier sees.

There is an additional noise whenever junction transistors are used in the input of an op-amp. This is called semiconductor or $1/f$ noise. The latter name, because it rises as the frequency goes down. This means that by reducing the bandwidth 2 to 1, you do not always reduce the noise as much as you expected. It also means that as the pass-band gets nearer to DC, the low frequency noise increases. This noise is dependent on the transistor or IC used and can be minimized by observing the manufacturer's recommended operating parameters.

A third, and ever increasing source of noise, is externally generated noise. This is noise generated from power lines, fluorescent lighting systems, diathermy machines and nearby radio transmitters. Also, most microprocessors are terrible offenders. Power line noise is generally handled by the common mode rejection of the amplifier. As the power line is modified by the arc discharge in a fluorescent light, it generates additional high frequency signals. If the amplifier band pass is much over 100 cycles these can become a problem, too. It is therefore necessary to assure the common mode rejection extends up to the high end of the amplifier band pass. It is also often necessary to shield fluorescent lights with grounded copper screens to reduce their radiation. RF noise generated by diathermy and radio transmitters is more difficult to reduce. Sometimes filtering between the + and - inputs of an amplifier with a small disc capacitor helps, but often for very low level measurements, it is necessary that they be conducted in a screened room.

BIO-MEDICAL SIGNALS

This is an article on medical electronics, so it would be good at this point to describe some of the more common bio-medical signals. Nerves and muscles within the body generate electricity by electro-chemical action. The electricity is generated by an ionic chemical reaction, similar to that in a battery, as opposed to electricity that is generated electro-magnetically, as in a generator. When a signal is sent down a nerve from the brain to one of the skeletal muscles, it is an electrical signal. When the muscle contracts, it also develops an electrical signal. These are the signals electronic instrumentation can measure.

The most familiar of these signals is the voltage generated by the pumping of the heart. A graph of this voltage is called an Electrocardiogram which is abbreviated EKG (or ECG, if your instructor didn't like German). This is the 'scope pattern one sees on the television doctor shows. The EKG signal is a periodic waveform with a rather spiked appearance occurring with one cycle equal to one heart beat. The frequency components range from 0.1 Hz up to 100 Hz and the amplitude is about 2.5 millivolts, peak to peak. These signals are detected by use of surface electrodes attached to various places across the chest and to the arms and legs.

Another important set of signals are the voltages generated by the skeletal muscles (i.e., the ones that move our arms and legs). Plots of these voltages are called electromyographs or EMG's. These signals are produced by the contraction of a single muscle cell and are smaller in amplitude, ranging from 50 microvolts to 200-300 microvolts. They are much faster and can have frequency components up to 10 KHz. They are generally observed by inserting a needle electrode directly into the muscle through the skin. I'm told it doesn't hurt, but I prefer to do my testing with a signal generator. The signals are

not periodic as in the EKG, but occur as the muscles contract. These signals can be detected with surface electrodes, but what happens then is the combination of many signals are observed and the frequency component is much lower. With the direct needle approach, an individual muscle cell or motor unit can be monitored.

Another important bio-medical signal is the EEG (Electroencephalograph, if you can say it), or brain waves. We have all seen these on TV or at the movies with the 6-channel recorder plotting the brain wave as the patient slipped off into dreamland. These signals are of very low amplitude, often 50 microvolts peak, but are of a relatively low frequency when observed with surface electrodes on the skull.

So, in summary, the body-generated voltages can vary over a wide range of frequencies; from 0.1 Hz to over 10KHz and over a wide range of levels from 5-10 microvolts peak to peak to over 5 millivolts peak to peak. It must be remembered that any time the body is instrumented, there is a chance of picking up noise from extraneous sources. It is not uncommon to see half a volt of 60 Hz riding on a subject, even though there is a good reference ground. A demonstration of this is to touch your finger to the probe tip of an oscilloscope and note the peak to peak voltage. I've seen as much as 20 volts with this test.

EXAMPLE: A COMPUTER INTERFACED CLINICAL EKG

I hope most of you have understood the above pages of theory, because now I'm going to get into the good stuff: an actual system. In recent years, there has been a substantial amount of study done by the U.S. Public Health Service, as well as many other public and private institutions towards the computer analysis of EKG's. I personally have seen a system running on an HP 2000 Series computer which appeared to do a very good pre-scanning of a patient's EKG. The computer did not take the place of a doctor for final decision making, but it allowed a technician to run an EKG, which then could be flagged if something looked abnormal.

Computer analysis of an EKG is generally based on a 12-lead EKG analysis. This is the name given to the various combinations of signals derived from 9 electrodes plus a reference connected to the patient. Table 1 shows the arrangements and names of the various leads. For analysis by the computer, it is necessary that some of these leads be taken concurrently, because it is important that the time relationship between the various signals be preserved. The computer program uses the time relationship to determine the angle of the vector of the voltage generated by the EKG wave form within the heart. In other words, as the muscles contract around the heart and pump the blood, the voltage will look like a dipole with a positive and negative sense. The angle at which this is pointing is important in the diagnosis of heart problems. So to do this, the voltages must be recorded simultaneously. Table 1 also shows the standard sequence for combining these 12 leads into 4 sets of 3 leads.

The usually accepted minimum specifications for an EKG and signal conditioning system are as follows:

- A) Frequency Response
 $\pm 0.5\text{db}$ for .14 - 50Hz
 $- 3\text{db}$ for .05 - 100 Hz
- B) Input Impedance
500K minimum
- C) CMR
 $- 60\text{db}$ at 60Hz
- D) Gain Stability
 $\pm 5\%$

Standard electrode connections for 12 lead EKG

Electrode	Name	Location
E0	Reference	Right leg
E1	LL	Left leg
E2	RA	Right arm
E3	LR	Left arm
E4	V1	
E5	V2	Spaced across chest
E6	V3	from patient's right
E7	V4	to left. See a medical
E8	V5	text for the exact
E9	V6	locations

ELECTRODES USED FOR 12 LEAD EKG:

Lead name	E1 LL	E2 RA	E3 LA	E4 V1	E5 V2	E6 V3	E7 V4	E8 V5	E9 V6
I		-	+						
II	+		-						
III	+	-							
aVr	-	+	-						
aVl	-	-	+						
aVf	+	-	-						
V1	-	-		+					
V2	-	-			+				
V3	-	-				+			
V4	-	-					+		
V5	-	-						+	
V6	-	-							+

Note: When more than one electrode has the same input sign (as in V2 where E1, E2 and E3 are -) the electrode signals must be averaged, not added.

LEAD GROUPING FOR TIME DEPENDENT ANALYSIS:

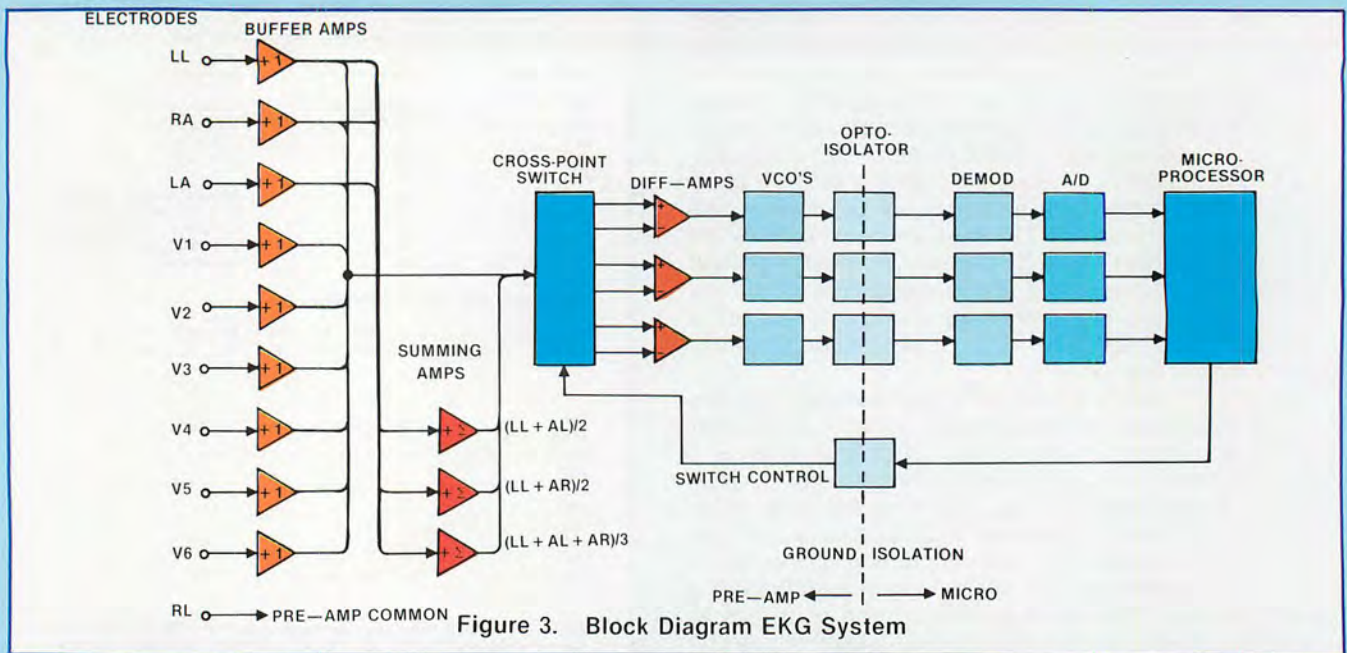
Lead Set:	1	2	3	4
Leads:	I II III	aVr aVl aVf	V1 V2 V3	V4 V5 V6

Table 1. EKG Electrode Connections

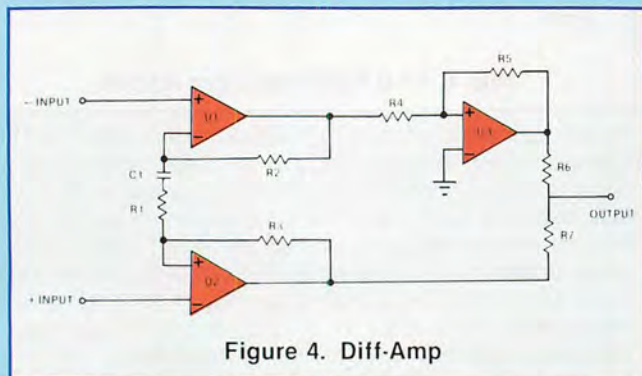
To the above specifications, I would like to add that the common mode impedance must be greater than 500K in order to obtain 60db common mode rejection with a normal electrode hook-up. This is because the electrode's impedance can be as high as 5K and a difference of 500 ohms between the impedance of electrodes with a 500K input impedance would limit the common mode rejection to 60db. Because of this, I suggest a common mode input impedance in excess of 100 megohms.

Let's assume that the approach in this EKG processing system will be to record 3 seconds of 1 set of 3 leads, then stop and load that data onto disk to save it. The next set of 3 leads can then be recorded and so on. To record the data, what really is necessary is to signal condition it with the appropriate amplifier, convert it with an analog to digital converter, and then store it in RAM. A good question is, how much RAM will it take? If a single lead is sampled once every millisecond, or 1000 samples per second, it should be easy to reconstruct a signal with a frequency response to 100 cycles. That means there are 1000 samples per second per lead. There are three leads for three seconds which equals 9000 samples. With an 8-bit A/D, this would take 9K of RAM. That's not too bad. In fact, one could take all 4 sets and put them into 36K if there was that much remaining after the control program was loaded. But assume for the time being, that a set will be stored and then moved to disk. This means there will be a gap between the sensing of the sets of leads, but that is no problem. The program should also control the timing and the selection of the various input signals to generate the proper EKG leads.

Figure 3 is the block diagram of the hypothetical system. The inputs are 9 electrode signals, referred to a common electrode. To minimize common mode problems, these should be buffered as near as possible to the patient. At the level of EKG signals, it is generally sufficient to buffer them with a unity gain amplifier. Naturally, differential amplifiers would be better, but much more complex and should be required only in high



noise environments. An LM-324 op-amp or a 741 type op-amp should work fine. A lower noise version of the 324, the Harris HA1-4741, will give improved performance.



It can be seen from Table 1 that some of the leads are generated by the average of various input signals. This average can be obtained by tying the 3 input leads together through averaging resistors, but this lowers the input impedance to the system and increases the common mode problems. A much better way is to do the averaging after the buffer amplifiers. Again, a simple op-amp circuit will handle this.

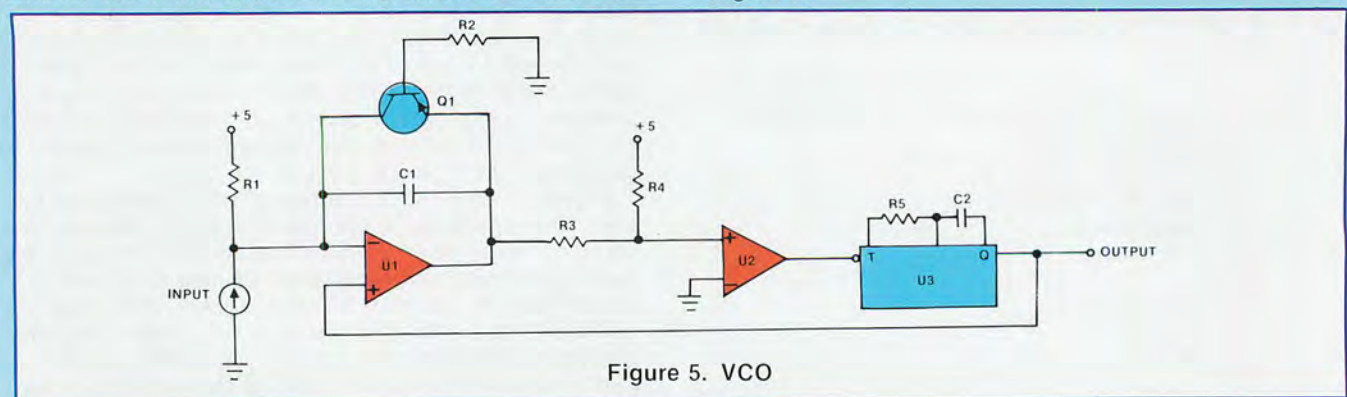
Next, there needs to be a multiplexer which is controlled by the computer to select the desired input leads and connect them to the differential amplifier. The leads shown (+) in Table 1 go to the non-inverting side of the diff-amp and the (-) signals to the inverting side.

Figure 4 is a diagram of a differential amplifier suitable for use in this circuit. It can provide a fair amount of

gain (up to 500:1) with only 1 low frequency time constant with good DC stability. Again, LM-324 op-amps will work fine in this circuit, but they must have low noise specs since the inputs are at their original level.

A brief description of the amplifier is as follows: The differential amplifier consists of 2 amplifiers, U1 and U2 with feedback resistors R2 and R3 driving into a common feedback network consisting of R1 and C1. R2 must equal R3. The inclusion of C1 gives each amplifier a DC gain of unity but an AC gain equal to $R2/(R1/2)$. The inclusion of C1 is mandatory since the electrodes can have DC offsets over 0.1 volt which would be amplified, causing saturation of the diff-amp. R1-C1 is an AC time constant in the low end of the system and must be sufficiently below the pass band to not cause any wave form distortion. The outputs of U1 and U2 are equal to the difference in the input signals times the gain determined by R1 and R2. Any common mode signal is also present, but it isn't amplified. Amplifier U3 removes the common mode component by inverting the U1 output and combining (subtracting) it with the U2 output through summing resistor R6 and R7. The current output from R6 and R7 is proportional to the difference in the input with any common signal removed. The resistors should all be 1% and R7 may be trimmed if necessary to balance the system for common mode signals. To test for common mode balance, drive both inputs with a common 1 volt 60 cycle signal and trim R7 for a null at the output.

As mentioned previously, for safety reasons, it is best to isolate the preamplifier from the system ground. This can be done by converting from voltage to frequency and then isolating it with an opto-isolator as shown in Figure 3.



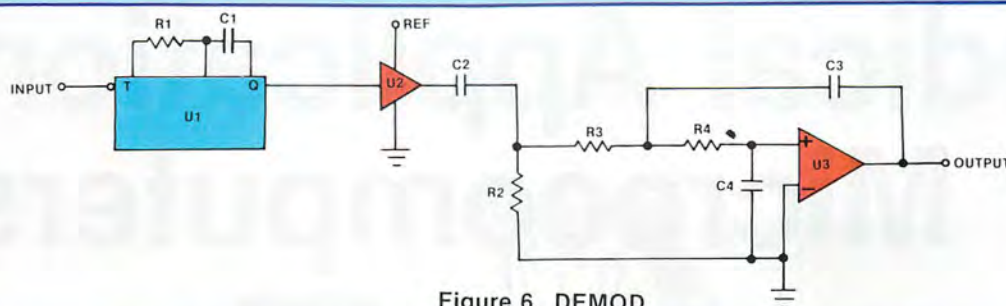


Figure 6. DEMOD

Figure 5 shows a circuit I like for linearly converting an input current to an output pulse train of varying frequency. This circuit will exhibit non-linearity of less than $\pm .2\%$ over a 3 to 1 change in frequency. Here is how it works. The input must be driven from a current source such as the summed output of the differential amplifier in Figure 4. This current is applied to the sum input of op-amp U1, along with a bias current from the power supply through R1. This input current will drive the output of the amplifier negative supplying current through C1 to balance the input current. This forces the voltage change across C1 to be a linear ramp proportional to the input current. If the output of U1 is allowed to fall to a fixed voltage and then is reset, the relationship between input current and repetition rate of the ramp is given by the following equations:

Across a capacitor,

$$dV/dT = I/C$$

where dV means the change in voltage and dT the change in time

or $1/dT = I/(C \cdot dV)$

If we could reset the circuit instantly, and if the change in V is fixed, i.e. $dV = V1$, then:

$$1/dT = I \cdot (1/(C \cdot V1))$$

or $1/dT = KI$

but $1/dT$ is frequency, so the frequency is proportional to input current

A divider from the +5 supply consisting of R3 and R4, which are generally made equal, allows the output of U2 to go to -5 volts before the junction of the divider crosses 0. At that point, it changes the output of the comparator U2 which is an LM-311. The comparator then triggers U3, the reset one-shot. The Q output of the one-shot goes positive for a time set by R5 and C2. The one-shot feeds back a pulse of a fixed width to the positive input of U2 which drives the output of U2 positive. When it drives positive, the base resistor, R2, connected to Q1 causes Q1 to conduct and clamps the voltage across the capacitor C1 to 0 preparing for the next ramp. It is important that this reset period be a very small percentage of the ramp length or it will cause non-linearities, but it must be long enough so that Q1 can completely discharge C1. This is not usually a difficult constraint if the frequency range is set from about 2KHz to 6KHz. The output from the one-shot is then used to drive an LED isolator.

There will now be a variable frequency pulse train proportional to the EKG signal at the computer side of the LED isolator. Referring to Figure 3, the next thing to do is to reconstruct the original wave forms. Figure 6 shows a circuit that is suitable for this purpose.

The operation of this circuit is based on the fact that if for each input pulse, an output pulse of fixed width and amplitude is generated, their long time average will be a DC voltage proportional to the input pulse frequency. It is mandatory that the output amplitude be fixed, and that the pulse width remain constant. To insure fixed

amplitude, a CMOS buffer is used, and as its power supply, a constant reference voltage.

The output impedance will be under 200 ohms and the buffer can switch from ground to the reference voltage with very little offset. The input pulse train triggers a one-shot, U1, whose output drives the CMOS buffer, U2 generating a train of pulses of fixed width and amplitude equal to the reference voltage. The average (DC) value of these pulses can vary from nearly zero to the reference voltage as the input frequency goes from DC to blue light. For maximum linearity, it should be kept between 0.2 and 0.8 times the reference.

Since this signal has a DC component (with respect to the EKG signal which had a zero average value) RC network R1-C1 is necessary to isolate the DC component. It is important to note that even though the input to this network is a pulse train, the network is really acting on the long term average of the DC level contained in the signal, and is therefore a low frequency term in the response of the total system. Its time constant must be low enough that it will properly handle the EKG information.

The remainder of the components form a low pass 2nd order filter. A description of this circuit can be found in most books on active filters (such as "Manual of Active Filter Design" by Hilburn and Johnson, published by McGraw Hill). This filter determines the high frequency response of the system, and should be set to provide a natural frequency of 100 Hz with a damping of 0.7. If the minimum VCO frequency is kept above 2KHz, the system noise contributed by the VCO chopping frequency should be at least 60db down from the full scale output of the system.

These blocks have been built and tested in various configurations and typical performance as follows:

- A) Frequency response: $\pm 0.5\text{db}$ 0.1 to 50 Hz
- 3db @ 0.04 Hz and 100 Hz
- B) Input impedance: 185 Megohm
- C) CMR: 110db @ 60Hz, $RS1 = RS2 = 5K$
89db @ 60Hz, $RS1 = 5K$; $RS2 = 10K$
- D) Gain: $\pm 2\%$, Temp = 5 to 45 deg C
- E) Nonlinearity: $\pm 0.5\%$
- F) Noise: 3.8 microvolts p-p,
 $RS1 = RS2 = 5K$

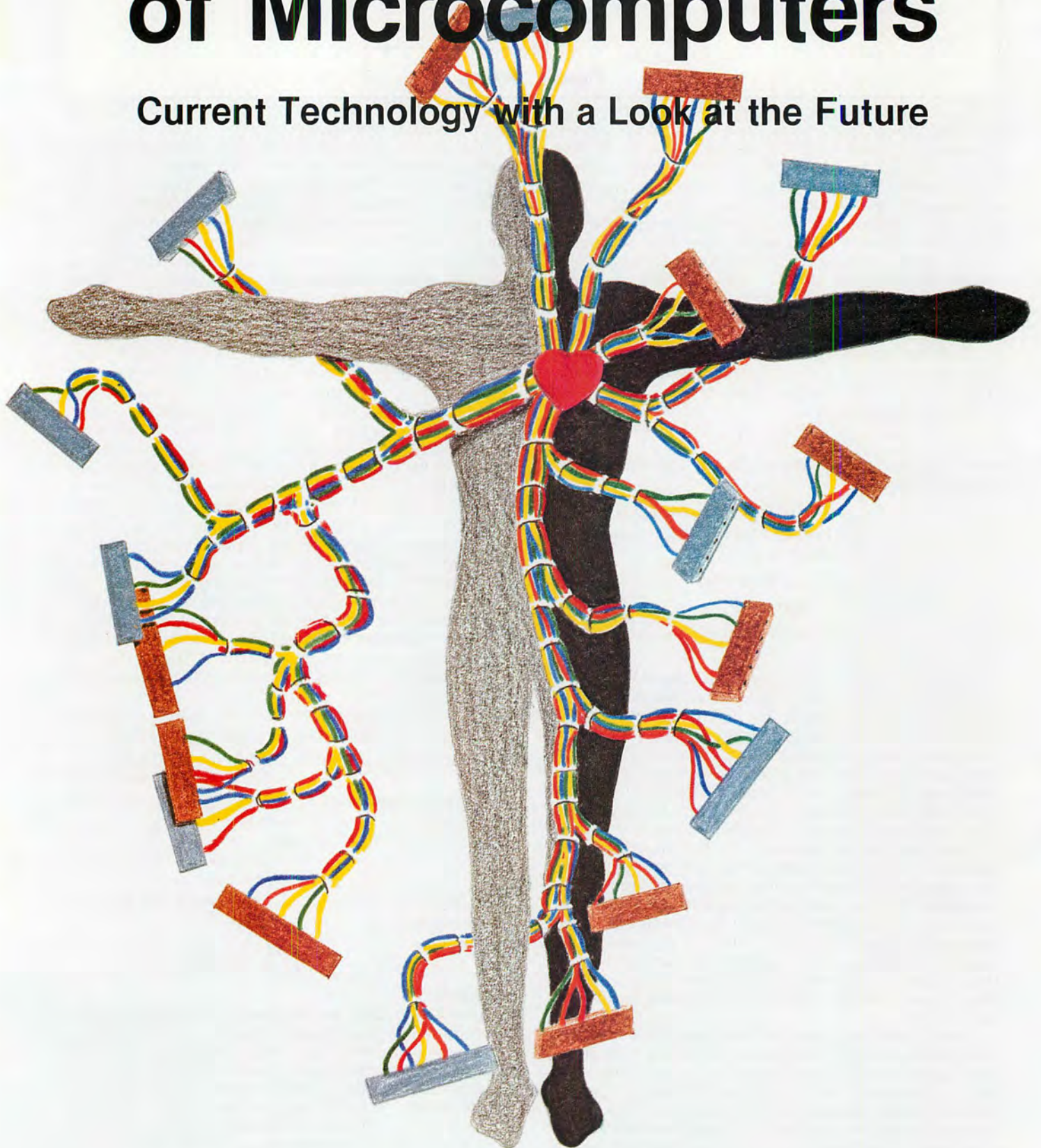
SUMMARY

The above circuits are intended to be a starting point to prod the imagination and ingenuity of my hardware-inclined readers. Hopefully, they will get together with some of the medical profession and a software expert or two, and advance the state of the art of bio-medical instrumentation. I don't mean to say that the small systems community can build a better system than the "Big Boys," but I'll bet they could do the job for a lot less money! □

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Medical Applications of Microcomputers

Current Technology with a Look at the Future



By Dick Moberg

Department of Neurosurgery, Jefferson Medical College

Computerized arms and legs . . . electronic speech synthesis . . . voice recognition . . . visual pattern recognition. Robots? No, humans! The introduction of microcomputers into the medical world has brought us a giant step closer to bionic people. Although at present the majority of medical applications of microcomputers are in making intelligent instruments (and smart they are!), in the near future we can expect to see microcomputers used in replacement parts for the body or to extend our present functions. In this article we will take a look at how microcomputers are being used in various health care areas today, and then we will briefly step into the future to see what we can expect.

THE BEGINNINGS

Biomedical engineers have long awaited the microcomputer to solve some of the problems in medicine. In medical instrumentation, safety and reliability are of utmost importance since, as in aviation and space electronics, lives depend on their correct function. So, when the microcomputers arrived and when engineers finally learned how to make them work, they were used immediately for data collection, signal processing and display, in addition to improving safety and reliability.

But even before the mass marketing of microprocessors, an engineer at Massachusetts General Hospital, Ed Trautman, realized the benefits of a programmable instrument. He put together some memory, logic, and a calculator chip to construct an instrument that, with nearly identical hardware, carried out two entirely different functions by mere software changes. The two instruments were a cardiac output computer and a neuromuscular transmission analyzer.

Although the instrument was calculator-based, Trautman saw the advantages of microcomputers in bio-engineering research and in hospital instrumentation. He predicted that with microcomputers:

- cost savings, increasing the number of instruments available to hospitals, researchers, and clinicians, might be produced by the ability to change instrument function with software changes.
- modifications and adaptations could easily be implemented to keep pace with changing requirements.

•functions which are now prohibitively expensive to instrument could be very possible.

•monitoring, which is currently far too expensive to provide commonly, could be available for every patient who might require it.

Trautman's predictions have largely come true in the four years since his original paper. One exception is that some manufacturers seemed to have used the new "computerized" capabilities of their instruments as an excuse to increase their prices when, in fact, they have decreased their production costs.

MICROCOMPUTERS AND MEDICAL INSTRUMENTATION

Although microcomputer systems are being used widely in medicine, medical applications account for only 3% of all uses of microcomputers. This, of course, is due to their mass consumption in the automotive, appliance, military, and personal computer markets.

By far the most prevalent use for microcomputers in medicine today is in making patient monitors "smart." These intelligent instruments process the raw signals from the patient, producing an output display which is clinically much more useful. This can be seen in Figure 1. The first example denotes how three different electrocardiogram (ECG) tracings can be electronically reduced to a single plot called a vectorcardiogram. The vectorcardiogram (VCG) is a spatial summation of the electrical activity of the heart and represents the net direction of heart muscle depolarization. Changes in the shape of the VCG can be used to diagnose a variety of heart conditions.

The second example shows how an electroencephalogram (EEG) can be processed to analyze its frequency content. An EEG, unlike an ECG from the heart, is a non-cyclic and seemingly random signal. Thus, it is more difficult to extract usable information from the EEG by mere visual inspection. Using fast fourier transform techniques, smart monitors can provide the physician with a chart indicating how the frequency content of the brain waves is changing in time.

These examples indicate how microcomputer-based

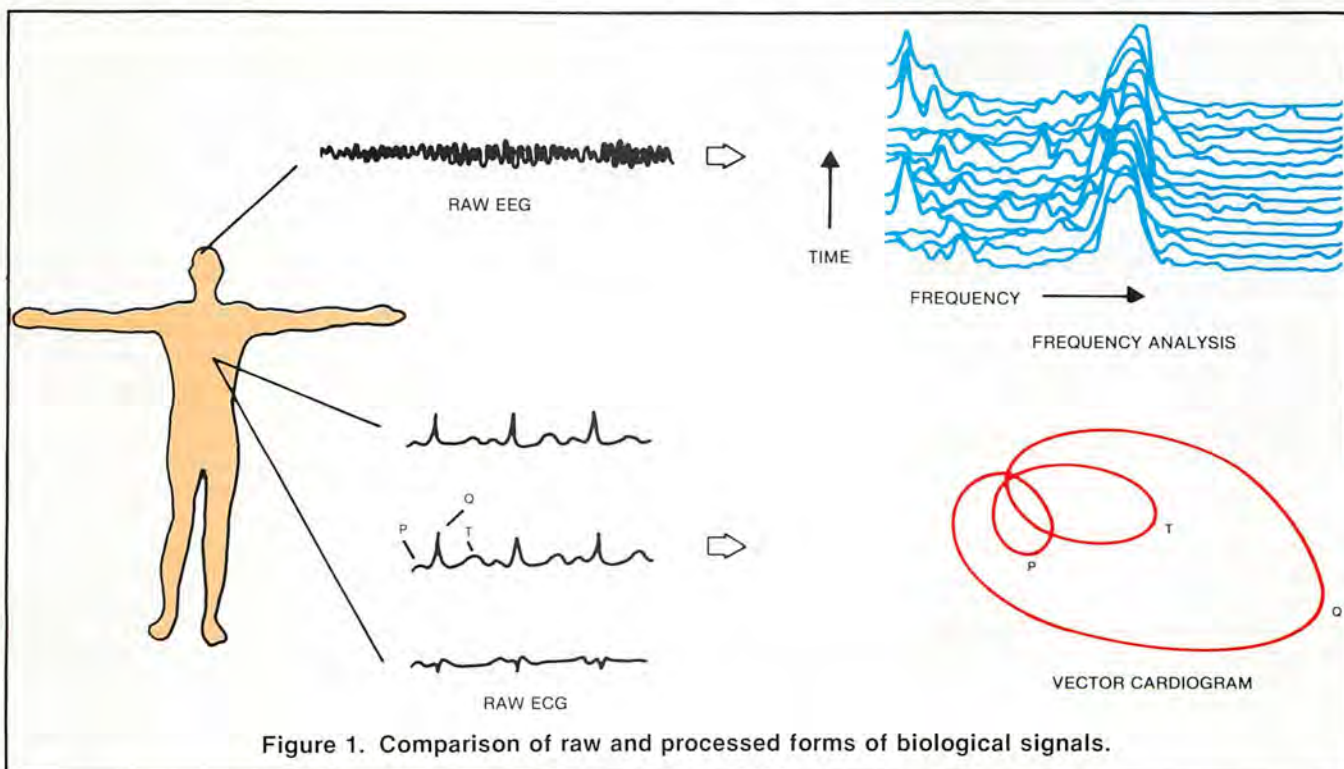


Figure 1. Comparison of raw and processed forms of biological signals.

monitors can be used to extract the clinically useful parameters from the raw physiological data. Presently, the raw EEG and ECG are used clinically more than the processed forms. However, with the future availability of smart monitors, the trend will continue towards computer extraction of more useful parameters.

Now let's look at some microcomputer-based medical instruments that have been designed to date. When an instrument contains a microcomputer, it can process data and also do several unrelated functions largely by software changes and, to a lesser degree, hardware additions and changes. Engineers at the Microcomputer Engineering Lab at MIT have used this concept and have designed a box containing a microcomputer into which a number of different modules may be plugged (Photo 1). The modules consist of such things as analog-to-digital converters; interfaces to Selectric typewriters, tele-types, and oscilloscopes for input and output; and interfaces to tape and disk systems for mass storage. Also included are modules which do signal processing such as spectral analyses and correlations.

By selecting the right combination of modules and programs, the following instruments may be realized:

- cardiac output monitor
- arrhythmia analysis monitor
- portable EKG computer
- vestibular function tester
- regional blood flow monitor
- pulmonary function tester
- microwave radiometer

Of course, countless other instruments may be made; the number is limited only by the user's imagination.

To aid the user in developing his own custom applications, the MIT engineers have developed a programming language called STOIC (for Stack Oriented Interactive Compiler). The language allows one to create his own commands to use the instrument as he pleases and eliminates the need for a technician having to learn a computer language. Since the instrument design is done only once (and no redesign and manufacturing need be done for each instrument configured), the cost of the system is drastically reduced, eliminating one of the problems of medical instrumentation today.

Another example to demonstrate just how smart these instruments are is a microcomputer-based patient monitor developed in San Diego. Completely contained inside one plug-in module for a standard physiological recorder, the unit was designed so the user needs only to turn the instrument on and connect the patient. The computer does the rest. It is primarily used for monitoring bioelectric data but can measure and process just about any of the important physiological parameters. In addition to its signal processing tasks, the system can automatically do the following:

- continually check itself for correct operation
- verify incoming data by checking lead impedances
- adjust analog input gain to keep signals within range
- calibrate itself
- notify medical personnel in case of emergency
- communicate with the physician by various displays

The prototype unit was built at a cost of \$3,000, but subsequent units could be manufactured for much less, making this computer-based instrument well within the budgets of most intensive care units.

What is commercially available today? Not a lot, but new products are appearing every week. There is a desk top pulmonary function computer which is pre-programmed with predictable normals for male or female, adult or child. The unit displays eleven different lung parameters calculated from a single breathing into a disposable sensor. The calculations take into considera-

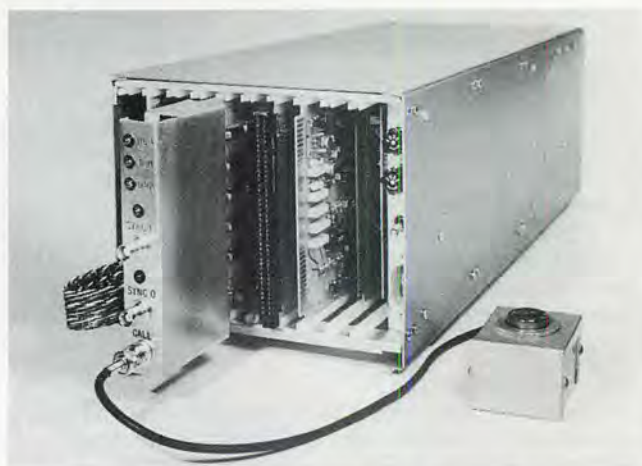


PHOTO 1 Medical Instrument Module Box

tion the age, sex, and weight of the patient, the values of which are entered prior to the test. The device is portable and requires minimal training to operate. Another device monitors the pulse rate of a person riding an exercise bicycle and calculates a "health factor" based on the rider's weight, age, sex, pulse rate, and the loading on the bicycle pedals.

In the previously mentioned devices, the microcomputers were used as "computers." In one of the new computer automated tomographic scanners (CAT scanners), they are used as "components" in a larger microcomputer-based instrument. The CAT scanner takes thousands of dot-sized X-ray pictures radially around a particular part of the body and reconstructs an image representing a "slice" through that part of the body. Four microcomputers are used to control the fast analog-to-digital converters that must be used to collect all the data in a reasonable amount of time.

Another widespread use at present is in automating the clinical laboratory. The microcomputers are being used to automate radio-immuno assays, differential blood cell counts, toxicological studies, and a host of other procedures.

COMPUTERS FOR THE HANDICAPPED

Most of the applications already mentioned could have used minicomputers although awkwardly and costly. Rehabilitation medicine, however, offers some areas of applications unique to a miniaturized controller such as a microcomputer. In particular, prosthetics (artificial limbs) is where much of the work has been concentrated.

The major problem with prostheses to date has not been so much with their mechanical nature but rather with their control. Electrical signals from muscles (EMGs) have been successfully used to control prosthetic devices. The more degrees of freedom in the artificial arm, indeed the more functional it is, the more complex must be the control signal from the muscles. That is, EMGs from many muscles must be used.

Two problems with obtaining these muscular control signals are: (1) the more muscles you "tap" for control signals, the more awkward is the device to wear, and (2) every amputee's stump is different as to the location and fidelity of the signals available. These problems, however, can be rather nicely solved using microcomputers. Using a microcomputer-based function separation algorithm, finer detection of usable control signals is possible allowing a reduced number of electrodes. And since the control function processing is done in software, parameter changes can be made to tailor each device to the individual wearing it (see INTERFACE AGE, June 1977).

But what about the severely handicapped, such as quadriplegics? How can they communicate with the world? How can they be educated? Quite possibly this will be accomplished by the movement of their eyes. Bioelectric signals from the eye muscles are one of the last physiological systems to be degraded in many neurological impairments. Noting this, Mr. Ira Laefsky, a student in the Computer and Information Science Department of the University of Pennsylvania is designing a microcomputer-based educational and environmental control device for the severely handicapped using eye muscle movements or electro-oculograms (EOGs) as the means of communication with the student (Figure 2). Various words or symbols are displayed on the TV-type-writer display. As the student looks at one, his eye positions are digitized and sent to the microcomputer, and in this manner he can "tell" the machine answers to questions (for educational purposes). He can also tell it to turn on lights, dial phones, and, if connected to a speech synthesizer, to talk.

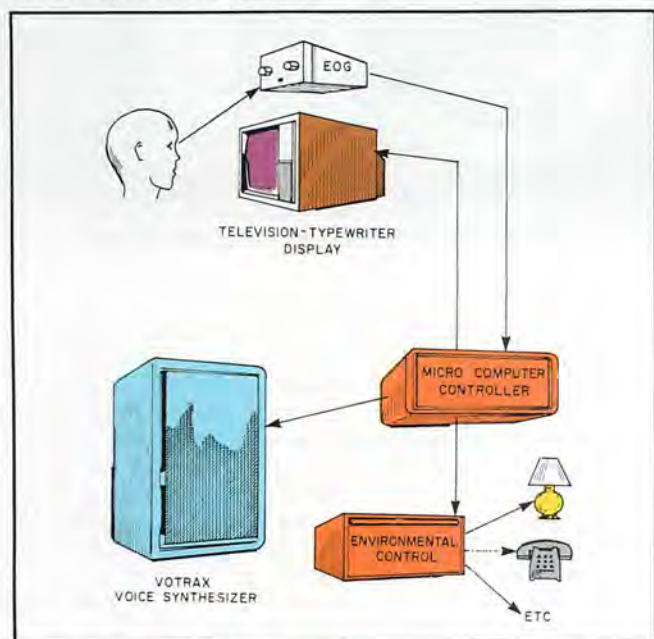


Figure 2. Educational and environment control device for the severely handicapped using electro-oculograms for person-computer communication.

There are many projects of varying degrees of difficulty that would be potentially beneficial to the handicapped, such as a talking terminal for the blind using a speech synthesizer, a voice input telephone dialer for the severely arthritic, a cheap and reliable device for embossing the Braille character set, and a computer communication network for shut-ins. Unfortunately, there are problems with the commercial development of these devices in that the market is limited for a particular device. Therefore, the price must be high, and many of the handicapped can barely afford even the most basic items presently available to them today.

To this end a small group of interested people, under the leadership of Dr. Robert Suding (The Digital Group), met at Personal Computing '77 in Atlantic City last August to discuss some problems of the handicapped and how the computer might help. Efforts of the group have largely been carried on by Warren Dunning of the Franklin Institute in Philadelphia and myself. The group's main purpose is to let people know what problems need solutions and also what items have potential applications towards helping the handicapped. We are doing this through articles in the computer publications, by having booths at the major computer shows, and by a

newsletter soon to be published. For more information on this group, write to Computers for the Handicapped, c/o Warren Dunning, 5939 Woodbine Avenue, Philadelphia, Pennsylvania 19131.

MEDICAL OFFICE MANAGEMENT

Small systems aimed at managing small medical practices are beginning to be seen. Several are available and are in the \$10-15,000 range. These usually include CPU, 32 to 64K memory, dual floppies, CRT, and printer. Software included covers patient information, treatment, accounts payable and receivable, insurance coverage, and payroll.

A new publication aimed at keeping the physician informed about office management systems as well as a host of other developments on microcomputers and medicine is now available. It is called Physicians Microcomputer Report and is edited and published by Dr. Gerald Orosz, Box 6483, Lawrenceville, NJ 08648.

THE FUTURE

Medical instrumentation will continue to shrink in size and double in capacity until the physician's black bag actually contains a tiny diagnostic computer system. Stethoscopes will connect to it for on-line recognition of abnormal heart sounds and ophthalmoscopes will be connected for visual studies. But there will be more. Pop a few electrodes on the patient and the black bag will do ECGs, nerve conduction studies, evoked potential analyses, EEG spectral analysis, and EMGs. It will then process the data, tell the doctor if there are any abnormalities, and store the data in its memory until the day's results can be dumped into a central hospital computer.

Hopefully, fewer people will be in the hospital due to the personal computer revolution. When the day arrives when home computers are as common as television sets and when all of these computers are tied into central information networks, primary medical care might just as well be done electronically. A fairly comprehensive physical examination could be carried out by an average person guided by a computer graphics terminal and using only a minimum of readily available, inexpensive instruments (penlight, tongue depressor, stethoscope, reflex hammer, etc.).

Before self-diagnosis programs come about, there will be programs dealing with preventive medicine, and rightly so. Health risk analyses, to help you prevent diseases, are just now appearing on computer screens. The computer asks whether you smoke, drink, exercise, what you eat, your weight, height, sex, and age, and many other questions. It then reports back with a health appraisal in the form of how many years you can expect to live continuing the same life style. Most important, it can analyze your life style, diet, and social habits and make recommendations for living a healthier life.

Prosthetics research, however, with its bionic flavor, will certainly be the field to lead us into the "far out" future of microcomputer applications in medicine. Artificial appendages will increase in complexity until they approach their human analogs. They will be complete, from the optimum control and functions down to artificial skin itself. The real advance that will grow out of this field will be the development of a method of direct brain-computer communication. Once this has been achieved we will truly step into the Bionic Age and hope for a peaceful symbiosis of man and computer. □

An annotated bibliography of microcomputer applications in medicine is being prepared by the author. If you are interested in receiving a copy or in corresponding about the impact of microcomputers in medicine, write to: Dick Mobert, Department of Neurosurgery, Thomas Jefferson University, Philadelphia, PA 19107.

INSIDE ASCII

CODE EXTENSION — GENERAL PRINCIPLES

Over ten years ago it was recognized that ASCII was the basis for codification of the various symbols used throughout the world. Through it, libraries could store encoded books as well as printed books. And while electronic mail may be quite simple with ASCII and its Roman alphabet, that's not the alphabet of all countries. The USSR uses Cyrillic, the Japanese use Katakana, and the Arab world uses its own semi-script alphabet. Moreover, to send a mathematics textbook by electronic mail one would have to be able to encode the formulas and special symbols peculiar to mathematics, which includes many Greek characters!

This is where the ESCape character and ESCape sequences come in. You can get the whole complicated story from ISO Standard 2022 (or ECMA-35) on Code Extension Procedures. But it will be easier to think of reproducing many ASCII Code Tables on the pages of a book, then replacing the ASCII symbols on all but the first page with the other alphabets we need.

Then we make sure that everyone in the world has the same (code) book. (The resemblance to military code books is intentional.) That's done by registering the page number assignment to characters (actually either a control set or a graphic set, but not both) with the French Standards Body AFNOR. That's the Association Francaise de Normalisation, Tour Europe Cedex 7, 92080 Paris La Defense, FRANCE. But you'll find it perhaps easier to get it from ANSI (see data in the first installment, INTERFACE AGE, May 1978).

The registration procedure is spelled out in ISO Standard 2375. It is carefully controlled to prevent frivolity and cluttering up the assignment books, for that all costs money. But the important control and graphic sets of the world may be registered and assigned their own unique ESCape sequence for calling or invoking them.

CODE EXTENSION — BASIC RULES

The control ESC, when encountered in a datastream, means that all characters following it, up to and including the first character from sticks 3 to 7, have special interpretation. The delimiting character is called a "final" (F). Those between ESC and the final are called "intermedi-

ates" (I). All of the codes in stick 2 can serve as intermediate characters in ESCape sequences of 3 or more characters in length. The entire group of characters from ESC through the final is called an ESCape sequence.

ESCape sequences obviously require buffers for interpretation, for we cannot know, when they begin, how long they will be. Sequences of length 2 are for single controls. If the character following ESC is from stick 3, the sequences are for private usage, of the class Fp. If it is from sticks 4 or 5, they mean single controls, of the class Fe, from an appropriate set of 32. If from sticks 6 or 7 (except 7/15), they are of the class Fs, composed of single controls. This is elementary extension.

A more complex type of extension is the simulation of one or more 8-bit character sets by alternating between two 7-bit sets. The home base set consists of the C0 (32 controls) set and the G0 (94 graphics plus space and DEL). The alternate sets consist of the C1 (32 controls) set and the G1 (94 graphics plus space and DEL). The 8-bit set (it doesn't have to be just theoretical if you have a full 8-bit capability) consists of the four parts C0-G0-C1-G1.

These four types of sets are all invoked (designated) by 3-character ESCape sequences in this manner, where F is the final (3rd) character:

Sequence	Invokes Set Type
ESC 2/1 F	C0
ESC 2/2 F	C1
ESC 2/8 (or 2/12) F	G0
ESC 2/9 (or 2/15) F	G1

The final character "F" selects the particular set to invoke. Once invoked, encountering or entering an SO shifts to the G1 set in force; an SI shifts to the G0 set in force. SO and SI do not affect the control set.

ISO Standard 2022 defines these matters in far more detail, but that is enough for here. That document is complicated and ingenious, and deserves substantial study.

THE CODE EXTENSION REGISTRY

Table 1 identifies the graphic sets registered to date. Table 2 identifies the control sets registered to date. Re-

PART 3 OF 3

PARTS

By R.W. Bemmer



member that these assignments, once registered, may never be changed!

The registry set is available from AFNOR for approximately 172 French francs, say \$35. It would be vital for an equipment or software manufacturer to have it, and it comes in a beautiful 4-ring binder symbolizing world-wide interchange compatibility. But the summary provided here will fill most needs.

...the work I had to do to compact the standard, trying to make it understandable, turned up more than unreadability. So it's back to the drawing board, perhaps for a considerable period of time. . .it's sometimes useful to have symbols whose meaning you can reassign without harm to programming languages. . .

Regis. No.	Final Char.	Name
002	4/0	IRV (Intl. Reference Version) Graphics
004	4/1	UK Graphics
006	4/2	US Graphics (ASCII)
008-1	4/3	NATS Main Graphic Set (Finland, Sweden)
008-2	4/4	NATS Additional Set (Finland, Sweden)
009-1	4/5	NATS Main Graphic Set (Denmark, Norway)
009-2	4/6	NATS Additional Set (Denmark, Norway)
010	4/7	Swedish Basic Graphics
011	4/8	Swedish Graphics for Names
013	4/9	JIS Katakana Graphics
014	4/10	JIS Roman Graphics
015	5/9	Italian Graphics
017	5/10	Spanish Graphics
018	5/11	Greek Graphics
019	5/12	Latin-Greek Graphics
021	4/11	German Graphics
025	5/2	French Graphics
027	5/5	Latin-Greek Mixed Graphics (Greek Capitals only)
031	5/8	Greek Alphabet Set for Bibliographic Use

For a G0 set the ESCape sequence is ESC 2/8 plus the final shown.
For a G1 set the ESCape sequence is ESC 2/9 plus the final shown.

Table 1. Registered Graphic Character Sets

Regis. No.	Final Char.	Name
001	4/0	ISO 646 Controls
007	4/1	Scandinavian Newspaper Controls
026	4/3	IPTC Controls

The ESCape sequence for a C0 set is ESC 2/1 plus the final shown.

Table 2. Registered Control Character Sets

CONTENT OF THE EXTENDED SETS

Figure 1a shows, against the ISO Code, International Reference Version, how the other graphic sets differ in the column/row positions shown. The rows are keyed to Table 1, reminding you that ASCII is "006", or "ISO 646-006".

From this figure we can see that many countries need accented letters as individual characters, not compound via BS (BackSpace). This is particularly true for the double sets 008 and 009, for Scandinavian newspaper transmission, which have characters that cannot be made from ASCII in compound form. For example — Ring-A, a solid, and the angle open and closed quotes.

col	02				03		04	05					06	07			
row	01	02	03	04	10	15	00	11	12	13	14	15	00	11	12	13	14
002	!	"	#	¤	:	?	@	[\]	^	_	`	{		}	-
004			£	\$													
006				\$													~
008-1				\$			ua	Ä	ö	Å	■		ub	ä	ö	å	
009-1		«	»	\$			ua	Æ	ø	Å	■		ub	æ	ø	å	
010								Ä	ö	Å				ä	ö	å	
011							É	Ä	ö	Å	Ü		é	ä	ö	å	ü
014				\$				Ÿ									
015			£	\$			§	°	ç	é			ù	à	ò	è	ì
017			£	\$			§	ı	ñ	ı				ñ	ç		~
018			£	\$			'										
019			£	\$..
021				\$			§	Ä	ö	Ü				ä	ö	ü	ß
025			£	\$			à	°	ç	§				é	ù	è	..
027	Ε		Γ		Ψ	Π	Δ	Ω	Θ	Φ	Λ	Σ					

Figure 1a. Registered Graphic Character Substitution

008-2 and 009-2 are shown in Figure 1b. Here these are not exceptions from the IRV, but rather the only graphics assigned in the set. The additions are necessary to set type for newspapers throughout Scandinavia. See the Crossbar-D, Crossbar-O, the A-E ligature, and the Icelandic Thorn.

col	04			05				06			07			
row	01	04	05	00	05	11	12	01	04	05	00	05	11	12
008-2	À	Ð	É	Ë	Ü	Æ	Ø	à	đ	é	þ	ü	æ	ø
009-2	À	Ð	É	Ë	Ü	Ä	Ö	à	đ	é	þ	ü	ä	ö

Figure 1b. Registered Additional Graphic Sets

Figure 1a doesn't show Set 031 because it deviates more and is not of that much general interest. It doesn't show the Japanese Katakana set because that is completely different from the IRV. In fact, Japanese Industrial Standard C6220-1969 is an 8-bit coded set with the IRV (see Set 014 for the dollar and yen signs) in the lower (bit 8 = 0) portion, and Set 013 in the higher portion, with space reserved for future additional controls. This Set 013 is shown in Figure 2. It is shown in its high-order position, to indicate the card codes at the same time.

Figure 2 also shows the Cyrillic set of the USSR state standard GOST 13052-67, but it is not half of an 8-bit set as the Japanese do it. Rather it is another page of extensions. After SO (Shift Out) is used, the Russian register is operative. Following SI (Shift In) it is the IRV. Although this set has no registry number now, it was submitted recently by ECMA, and we expect an assignment soon. By the way, both Katakana and Cyrillic are shown in their OCR font.

Figure 3 shows the contents of the registered control sets. Set 007 serves as control set for the graphic sets 008-1,2 and 009-1,2, for Scandinavian newspaper transmission. And set 026 is the control set for the worldwide newspaper transmission, defined by the IPTC (International Press Telecommunications Council). The 18 control positions not shown, and those where there is no entry, are the same as in the International Reference Version (646-001).

These newspapers are driving composition equipment, not line printers, so they don't need VT and FF. Their set is already defined, so they don't need SO and SI. They have (properly) assigned meaning to three device controls. And they're probably not doing payroll, so they don't need the four information separators. But they do transmit, and instead of choosing their own functions and placement they have chosen to be a registered variant of the ISO Code. And all variants within this controlled and registered cluster can at least recognize each other, even if they can't print it!

			1000	1001	1010	1011	1100	1101	1110	1111
b ₈ b ₇ b ₆ b ₅	b ₄ b ₃ b ₂ b ₁	COL ROW	8	9	10	11	12	13	14	15
0000	0		ア	イ	ウ	エ	オ	カ	キ	ク
0001	1		コ	ケ	コ	セ	ソ	タ	チ	ツ
0010	2		テ	ト	ナ	ネ	ニ	ノ	ハ	ヒ
0011	3		フ	ボ	バ	ビ	ブ	ペ	ポ	プ
0100	4		マ	ミ	ム	メ	モ	ヤ	ユ	ヨ
0101	5		ラ	リ	ル	レ	ロ	ワ	ヰ	ヱ
0110	6		ヰ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
0111	7		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1000	8		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1001	9		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1010	10		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1011	11		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1100	12		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1101	13		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1110	14		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ
1111	15		ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ	ヱ

Figure 2. Katakana and Cyrillic Sets

Position	IRV			
	001	007	026	
0/09	HT	FO	FO	Format Control
0/11	VT	ECD	ECD	End (a typographical) Command
0/12	FF	SCD	SCD	Start (") Command
0/13	CR	QL	QL	Quad Left
0/14	SO	UR		Upper Rail
0/15	SI	LR		Lower Rail
1/01	DC1		Font 1	Change to normal
1/02	DC2		Font 2	Change to italic
1/03	DC3		Font 3	Change to bold
1/08	CAN	KW	KW	Kill Word (through previous space)
1/12	FS	SS	SS	SuperShift
1/13	GS	QC	QC	Quad Center
1/14	RS	QR	QR	Quad Right
1/15	US	JY	JY	Justify

Figure 3. Registered Control Character Substitution

CODE EXTENSION IN ACTION

To illustrate the operation of code extension, let's imagine some equipment that may not exist now:

- A microfiche reader with automatic location controls.
- A microfiche with ASCII (the 8-bit form) on the first two pages, the other pages containing other sets such as Katakana, Cyrillic, Arabic, Greek, Hebrew, mathematical symbols, astronomical symbols, etc. Also, symbol sets for selecting typestyles, weights, rotations, sizes, and elongations.
- A display screen for the microfiche; it is touch-sensitive and generates 7-bit codes according to location touched on the display.

- As an alternative, keyboard tops with fibre optic bundles molded in as a matrix, so that the keytops can be lighted with different symbols as selected.

Now imagine that we are writing an astrology book:

- Type

Those of you born under the sign of Aries (

- Depress the "astro" key on the special keyboard
- Notice the shift in display for the fiche screen and/or the keytop lighting
- Touch the Aries symbol on the screen (or the keytop)
- Depress SI (Shift In) on the special keyboard
- And return to typing the rest of the sentence

) will find this month ...

Now imagine what a computer would do to the input stream in driving photocomposition equipment. The "astro" key generated an ESCape sequence for an astronomical graphic symbol set that would have been registered by AFNOR. When the input parser recognizes ESC, it analyzes the following characters, and then calls this set of character formation methods from the backup store, generates the character shape for Aries according to the character code after the final character, notices SI, and returns to normal mode.

Now we can envision how all of the world's printed material can be stored in machine-readable form, and interchanged recognizably!

ALTERNATE CONTROLS

Work has been in progress for several years to develop a companion standard for controls for devices such as CRT terminals. In the US this is contained in the ANSI document BSR X3.64, Additional Controls for Character Imaging. In a similar form, this C1 set is before the Codes Committee of ISO Technical Committee 97 (Computers and Information Processing) as document 2 N 868, for consideration at its 1978 May 24-26 meeting.

I had hoped to give the essence of this work in this installment. There were only two negative votes in X3, which one could presume might be answered. Unfortu-

nately, the work I had to do to compact the standard, trying to make it understandable, turned up more than unreadability. It turned up many logical flaws and ambiguities. So it's back to the drawing board, perhaps for a considerable period of time.

Figures 4a through 4e will give, however, some flavor of the controls under consideration.

Figure 4 shows the controls of Format Type (FT) 1 and 2. Format 1 is either the single character of the 8-bit set, shown in the first column as "Ce", or the 2-character sequence of the type "ESC Fe", where Fe is a final character taken from 4/00 to 5/15, and whose column designation is 4 less than Ce. I.e., in an 8-bit code, INDEX would be 8/04. In a 7-bit code it would be ESC 4/04. Format 2 is of the type "ESC Fs", where Fs is a final taken from 6/00 to 7/14.

Figures 4b through 4e show controls with formats beginning with the control "CSI", defined in Figure 4a to be either 9/11 (in the 8-bit set) or "ESC [" (in the 7-bit sets). The six possible formats are:

3a = CSI Pn F

4a = CSI Pn I F

3b = CSI Pn ; Pn F

4b = CSI Pn ; Pn I F

3c = CSI Ps F

4c = CSI Ps I F

Pn stands for numeric parameter(s), Ps for a variable number of selective parameters separated by semicolons. The type 4 formats differ from type 3 only in inserting the intermediate character 2/00 just prior to the final.

In the figures, the parameter value enclosed in parentheses is the default value. That is, if the parameters are not actually inserted, i.e., being null, then the effect is the same as if the default value(s) were inserted.

To give an example of how these controls operate, look in Figure 4d for the second mnemonic, SGR (Select Graphic Rendition). It is represented first by CSI, the Control Sequence Introducer, the parameter, and the final 6/13. This means that when the 4-character string

ESC [6 m

is encountered, it should turn on rapid blink in the field(s) specified on your video screen.

AL = Active Line (containing AP)
 AP = Active Position (where the cursor is)
 EF = Editor Function
 FE = Format Effector
 HT = Horizontal Tabulation
 IN = INtroducer
 PAD = Primary Auxiliary Device
 RD = Received Datastream
 SAD = Secondary Auxiliary Device
 SD = String Delimiter
 VT = Vertical Tabulation
 QA = Qualified Area (defined by DAQ, SPA, EPA)
 rfs = reserved for future standardization

Abbreviations for Figures 4a through 4e.

Ce	FT	Type	Param	Mnem	Name
8/00-03	1				(rfs)
8/04	1	FE		IND	INdEx
8/05	1	FE		NEL	NEXt Line
8/06	1			SSA	Start of Selected Area
8/07	1			ESA	End of Selected Area
8/08	1	FE		HTS	Horizontal Tabulation Set
8/09	1	FE		HTJ	Horiz. Tabul. with Justification
8/10	1	FE		VTS	Vertical Tabulation Set
8/11	1	FE		PLD	Partial Line Down
8/12	1	FE		PLU	Partial Line Up
8/13	1	FE		RI	Reverse Index
8/14	1	IN		SS2	Single Shift 2
8/15	1	IN		SS3	Single Shift 3
9/00	1	SD		DCS	Device Control String
9/01	1			PU1	Private Use 1
9/02	1			PU2	Private Use 2
9/03	1			STS	Set Transmit State
9/04	1			CCH	Cancel CHAracter
9/05	1			MW	Message Waiting
9/06	1			SPA	Start of Protected Area
9/07	1			EPA	End of Protected Area
9/08-10	1				(rfs)
9/11	1	IN		CSI	Control Sequence Introducer
9/12	1	SD		ST	String Terminator
9/13	1	SD		OSC	Operating System Command
9/14	1	SD		PM	Privacy Message
9/15	1	SD		APC	Application Program Command

Fs	FT	Mnem	Name
6/00	2	DMI	Disable Manual Input
6/01	2	INT	INTerrupt
6/02	2	EMI	Enable Manual Interrupt
6/03	2	RIS	Reset to Initial State

Figure 4a. Controls for Character-Imaging Devices

Final	FT	Type	Param	Mnem	Name
4/00	3a	EF	(1)	ICH	Insert CHAracter
4/01	3a	EF	(1)	CUU	CURsor Up
4/02	3a	EF	(1)	CUD	CURsor Down
4/03	3a	EF	(1)	CUF	CURsor Forward
4/04	3a	EF	(1)	CUB	CURsor Backward
4/05	3a	EF	(1)	CNL	Cursor Next Line
4/06	3a	EF	(1)	CPL	Cursor Preceding Line
4/07	3a	EF	(1)	CHA	Cursor Horizontal Absolute
4/08	3b	EF	(1;1)	CUP	CURsor Position
4/09	3a	EF	(1)	CHT	Cursor Horizontal Tabulation
4/10	3c	EF		ED	Erase in Display
			(0)		From AP to end (inclusive)
			1		From start to AP (inclusive)
			2		All of display
4/11	3c	EF		EL	Erase in Line
			(0)		From AP to end (inclusive)
			1		From start to AP (inclusive)
			2		All of line
4/12	3a	EF	(1)	IL	Insert Line
4/13	3a	EF	(1)	DL	Delete Line
4/14	3c	EF		EF	Erase in Field
			(0)		From AP to end (inclusive)
			1		From start to AP (inclusive)
			2		All of field
4/15	3c	EF		EA	Erase in Area
			(0)		From AP to end (inclusive)
			1		From start to AP (inclusive)
			2		All of QA
5/00	3a	EF	(1)	DCH	Delete CHAracter
5/01	3c			SEM	Select editing Extent Mode
			(0)		Edit in display
			1		Edit in AL
			2		Edit in field
			3		Edit in QA
5/02	3b		(1;1)	CPR	Cursor Position Report
5/03	3a	EF	(1)	SU	Scroll Up
5/04	3a	EF	(1)	SD	Scroll Down
5/05	3a	EF	(1)	NP	Next Page
5/06	3a	EF	(1)	PP	Preceding Page
5/07	3c	EF		CTC	Cursor Tabulation Control
			(0)		Set HT stop at AP
			1		Set VT stop at AL
			2		Clear HT stop at AP
			3		Clear VT stop at AL
			4		Clear all HT stops in AL
			5		Clear all HT stops in device
			6		Clear all VT stops in device
5/08	3a	EF	(1)	ECH	Erase CHAracter
5/09	3a	EF	(1)	CVT	Cursor Vertical Tabulation
5/10	3a	EF	(1)	CBT	Cursor Backward Tabulation

Figure 4b. Controls for Character-Imaging Devices

Final	FT	Type	Param	Mnem	Name
6/00	3a	FE	(1)	HPA	Horizontal Position Absolute
6/01	3a	FE	(1)	HPR	Horizontal Position Relative
6/02	3a		(1)	REP	REPeat
6/03	3a		(0)	DA	Device Attributes
6/04	3a	FE	(1)	VPA	Vertical Position Absolute
6/05	3a	FE	(1)	VPR	Vertical Position Relative
6/06	3b	FE	(1;1)	HVP	Horiz. and Vertical Position
6/07	3c	FE		TBC	Tabulation Clear
			(0)		Clear HT stop at AP
			1		Clear VT stop at AL
			2		Clear all HT stops in AL
			3		Clear all HT stops
			4		Clear all VT stops
6/08	3c			SM	Set Mode
			1	GATM	Guarded Area Transfer Mode
			2	KAM	Keyboard Action Mode
			3	CRM	Control Representation Mode
			4	IRM	Insertion-Replacement Mode
			5	SRTM	Status Reporting Transfer Mode
			6	ERM	ERasure Mode
			7	VEM	Vertical Editing Mode
			8		(rfs)
			9		(rfs)
			10	HEM	Horizontal Editing Mode
			11	PUM	Positioning Unit Mode
			12	SRM	Send-Receive Mode
			13	FEAM	Format Effector Action Mode
			14	FETM	Format Effector Transfer Mode
			15	MATM	Multiple Area Transfer Mode
			16	TTM	Transfer Termination Mode
			17	SATM	Selected Area Transfer Mode
			18	TSM	Tabulation Stop Mode
			19	EBM	Editing Boundary Mode
6/09	3c		20	LNLM	Line feed New Line Mode
				MC	Media Copy
			(0)		To PAD
			1		From PAD
			2		To SAD
			3		From SAD
			4		Turn OFF copying RD to PAD
			5		Turn ON copying RD to PAD
			6		Turn OFF copying RD to SAD
			7		Turn ON copying RD to SAD

Figure 4c. Controls for Character-Imaging Devices

Final	FT	Type	Param	Mnem	Name
6/10-11					(rfs)
6/12	3c			RM	Reset Mode
					(same parameters as SM)
6/13	3c	FE		SGR	Select Graphic Rendition
			(0)		Primary rendition
			1		Bold, or increased intensity
			2		Faint, decreased intensity, or secondary color
			3		Italic
			4		Underscore
			5		Slow blink (< 2.5/second)
			6		Rapid blink (> 2.5/second)
			7		Negative (reverse) image
			8		(rfs)
			9		(rfs)
			10		Primary Font
			11-19		1st to 9th alt. font (via FNT)
			20		Fraktur
6/14	3c			DSR	Device Status Report
			(0)		Ready, no malfunctions detected
			1		Busy - retry later
			2		Busy - DSR will notify ready
			3		Malfunction - retry
			4		Malfunction - DSR will notify ready
			5		Please report status (DSR or DSC)
			6		Please report AP via CPR
6/15	3c			DAQ	Define Area Qualification
			(0)		Accept all input
			1		Accept no input (protected); do not transmit (guarded)
			2		Accept graphics
			3		Accept numerics
			4		Accept alphabetics
			5		Right justify in area
			6		Zerofill in area
			7		HT stop at start of area (field)
			8		Accept no input (protected); permit transmit (unguarded)
			9		Spacefill in area

Figure 4d. Controls for Character-Imaging Devices

Final	FT	Type	Param	Mnem	Name
4/00	4a	EF	(1)	SL	Scroll Left
4/01	4a	EF	(1)	SR	Scroll Right
4/02	4b	FE	(100;100)	GSM	Graphic Size Modification
4/03	4a	FE		GSS	Graphic Size Selection
4/04	4b	FE	(0;0)	FNT	Font selection
			(0;0)		Primary font
			1;0		First alternative font
		
			9;0		Ninth alternative font
4/05	4a	FE		TSS	Thin Space Specification
4/06	4c	FE		JFY	JustiFY
			(0)		Terminate all justify actions
			1		Fill action ON
					(text to/from other lines)
			2		Interword spacing
			3		Letter spacing
			4		Hyphenation
			5		Flush left margin
			6		Center text between margins
			7		Flush right margin
			8		Italian form (underscore last)
4/07	4b	FE		SPI	SPacing Increment
4/08	4c	FE		QUAD	Quad
			(0)		Flush left
			1		Flush left, fill with leader
			2		Center
			3		Center, fill with leader
			4		Flush right
			5		Flush right, fill with leader

Figure 4e. Controls for Character-Imaging Devices

Code	Symbol	Code	Symbol
10/00	(same as 02/00)	11/00	Large circle
10/01	Opening double quote	11/01	Dagger
10/02	Closing double quote	11/02	Superior (superscript) 2
10/03	Club suit	11/03	Superior (superscript) 3
10/04	Diamond suit	11/04	Rectangle
10/05	Heart suit	11/05	Parallel
10/06	Spade suit	11/06	Partial derivative
10/07	Closing single quote	11/07	Lower left corner, floor
10/08	Is implied by	11/08	Upper left corner, ceiling
10/09	Implies	11/09	Upper right corner
10/10	Multiply	11/10	Lower right corner
10/11	Plus or minus	11/11	Perpendicular
10/12	Nabla, or del	11/12	Less than or equal
10/13	Em dash	11/13	Not equal, other than
10/14	Radix point	11/14	Greater than or equal
10/15	Divide	11/15	Paragraph mark, pilcrow
12/00	Section mark	13/00	Capital pi
12/01	Double dagger	13/01	Capital psi
12/02	Dot bullet	13/02	Square bullet
12/03	Capital theta	13/03	Capital sigma
12/04	Capital delta	13/04	Integral
12/05	At least one exists	13/05	Capital upsilon
12/06	Capital phi	13/06	Therefore
12/07	Capital gamma	13/07	Capital omega
12/08	Upward arrow	13/08	Downward arrow
12/09	Right arrow	13/09	Left arrow
12/10	Dot product	13/10	Approximately equal
12/11	Degree	13/11	Opening angular bracket
12/12	Capital lambda	13/12	Logical AND
12/13	Register	13/13	Closing angular bracket
12/14	Copyright mark	13/14	Logical NOT
12/15	Capital xi	13/15	Infinity
14/00	Opening single quote	15/00	Small pi
14/01	Small alpha	15/01	Small psi
14/02	Small beta	15/02	Small rho
14/03	Small theta	15/03	Small sigma
14/04	Small delta	15/04	Small tau
14/05	Small epsilon	15/05	Small upsilon
14/06	Small phi	15/06	Check mark, radical mark
14/07	Small gamma	15/07	Small omega
14/08	Small eta	15/08	Small chi
14/09	Small iota	15/09	Logical universal quantifier
14/10	Identically equivalent	15/10	Small zeta
14/11	Small kappa	15/11	Cap intersection
14/12	Small lambda	15/12	Logical OR
14/13	Small mu	15/13	Cup, union
14/14	Small nu	15/14	Overbar
14/15	Small xi	15/15	(same as 7/15)

Table 3. Names of the Additional Graphics, 8-bit Set

	08	09	10	11	12	13	14	15
0					§	Π	'	π
1			"	†	‡	Ψ	α	ψ
2			"	²	•	■	β	ρ
3			♣	³	Θ	Σ	θ	σ
4			♦	□	Δ	∫	δ	τ
5		RESERVED FOR CONTROLS	♥	ℓ	Ξ	Τ	ε	υ
6			♠	ð	Φ	∴	φ	✓
7			,	ℓ	Γ	Ω	γ	ω
8			©	ℓ	†	↓	η	χ
9			∩	ℓ	→	←	ι	ν
10			×	ℓ	•	≡	≡	ξ
11			±	ℓ	°	<	κ	η
12			√	ℓ	Λ	Λ	λ	ν
13			—	ℓ	⊗	>	μ	υ
14			◆	ℓ	⊙	ℓ	ν	—
15			÷	ℓ	≡	∞	ξ	

Figure 5. 8-bit ASCII Proposal

CODE EXPANSION

We have seen how ASCII was *extended* by making many related pages of the 7-bit code. It is also possible to *expand* ASCII into an 8-bit code, or even 9-bit and 10-bit if we wished, for that matter. But an 8-bit code is obviously the most logical one to concentrate on, and this has been under development for several years.

The proposed 8-bit Expanded ASCII Code is shown in Figure 5. The identification of the graphic symbols is given in Table 3.

One can observe many interesting things about this set. For example, it has the entire Greek set of small letters except for "omicron", with eleven capitals to go with others from the Roman capitals to complete the Greek set. But apparently the committee didn't follow 646-031, the Greek alphabet mentioned in Table 1. They didn't use the customary ordering "alpha-beta-gamma", the way we learn our "a-b-c's". I suppose it is argued that this set will never be used for language, only math symbols. And 646-027, shown in Figure 1a, does not demand the special capital "upsilon" shown in position 13/5. If the Greeks can agree to using a Roman capital "Y" for upsilon, could the Americans?

You'll notice some math symbols, but not enough for APL. In fact, the whole set seems highly slanted to mathematics, rather than business. Of course there are the four corner symbols for forms. Presumably the card suits will strike your eye, and you will wonder why so many other useful symbols were ignored in favor of these. Don't worry, they will always come in handy; it's sometimes useful to have symbols whose meaning you can reassign without harm to programming languages, etc. The committee were obviously bridge players, for spades collate high.

This proposal has not had real public scrutiny yet, and it must be considered no more than a proposal. Presumably X3 will agree about July that it should be sent out for formal public review and letter ballot. My guess is that it will not be adopted in just the form you see here.

FUTURE FOR ASCII

The methods are in place for codifying all symbols that people use. They may be language alphabets, signs, drawing symbols, or controls for equipments. Robots, for example. Satellites are augmenting conventional telecommunications systems, so that one can borrow cheaply and permanently from electronic libraries.

To prepare for this, other sets are being developed for registry, many through ISO Technical Committee 46/1, Automated Documentation. A 2-page mathematical symbol set is near submission, as are African sets. Work is started for Arabic, which will take about 5 sets to handle fully, although there is a commercial subset of 94 graphics. Another C1 set is being proposed for bibliographic controls. It contains four types — annotation controls, filing controls, reference controls, and subject designators. Other C1 sets can come from process control, animation and other graphics applications, etc.

West Germany has proposed a new ISO project on text communication, to harmonize teleconnection of the more than one hundred varieties of typewriters (and keyboards) throughout the world. The extension method of multiple 7-bit codes is ideal for this (8-bit codes imply too many keys or shift combinations for people to use easily).

I am convinced that microcomputer users are going to develop some fantastic applications that will become widespread enough for their special graphic and control sets to be registered. How about a control set or two for sewing machines?

In fact, it is very difficult to think of any general application where one could not find a usage for these registered variants and extensions. □

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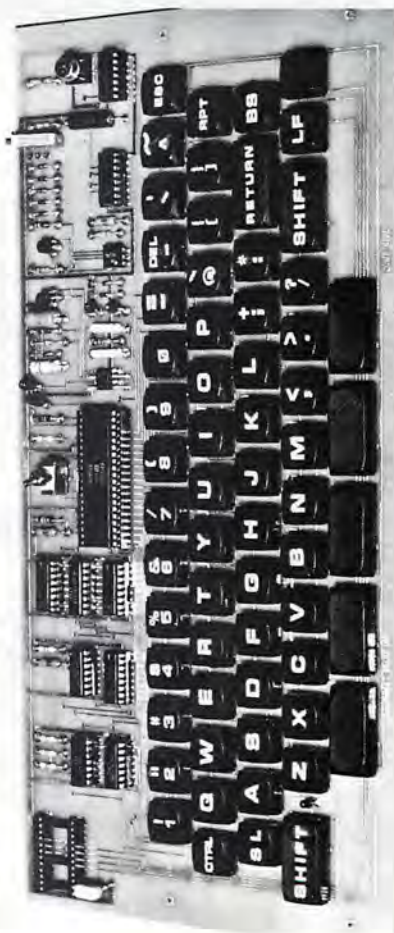
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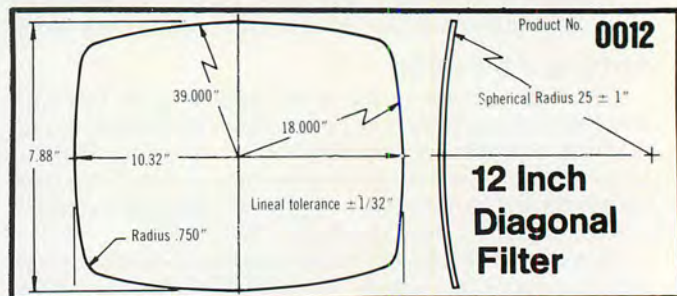
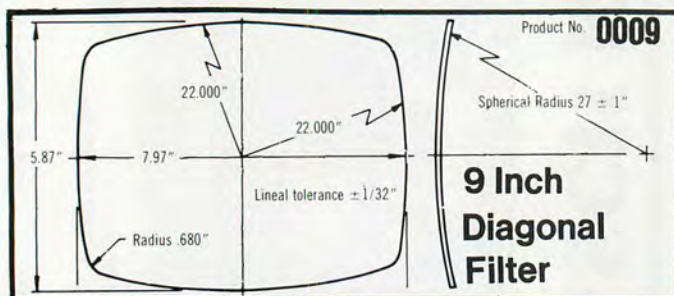
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BUSINESS EDITORIAL

By Neal A. Moran

SMALL BUSINESS = BIG DOLLARS FOR GROWTH ORIENTATED COMPUTER STORES

Just about all the experts in the micro industry now agree that small business is ready to computerize. In contrast, there seems to be little agreement on what small business expects from computer manufacturers and distributors. Information gleaned from ads, brochures, trade shows, and journals would seem to indicate that businessmen have become aware of turnkey microcomputer systems and view them as a means of regaining some competitive standing with respect to their larger, fully computerized colleagues.

The major manufacturers, such as IBM, NCR, Burroughs, and Litton offer excellent hardware, system design, and *canned* software in their product lines, but lack the flexibility to offer full peripheral support to the independent small business. The rigidity of these generalized systems, coupled with base "up-and-running" prices running from \$23,000 upward, have given the "Main Street, U.S.A." businessman the attitude that the majors don't really want his business.

What small business is measuring, relevant to EDP, is not just comparison with manual processing in terms of speed, accuracy, and management reportage. An equal, if not greater, factor is the cost comparison between manual processing and computer processing. In other words, if the lease (preferred) figure of a complete system equals or exceeds the cost of manual processing monthly, the independent businessman will see little advantage in computerization. Cost is his prime concern. He is similarly unimpressed with elegance: if a complete payroll application will add \$2,000 to the price of his system, he would just as soon write those 8 to 25 checks manually each week. Systems which fail to take these factors into account are not going to be accepted by the small business community.

On one marketing point, there is agreement between the experts and small business: if at all possible, small business will buy from local sources with established service support. Some "captive" computer stores, such as the Altair group, are becoming aware of this and are developing all-out marketing programs geared to small business. But even those stores which have recognized the potential of the small business market have, so far, maintained the passive stance they enjoyed with the hobbyist.

It may be of interest to computer stores that companies like ours, in total system consultation, are preparing store offerings including system design, custom software, and marketing and service development. We, like most microsystem designers, measure our experience with small business systems in months rather than years.

In our contacts with small business, we have yet to meet an owner/manager who was aware that microcomputers existed! So much for trade rumors. We have concluded that, with the exception of the informational seminars we hold periodically, *the customer is not going to come to us*. The customer doesn't read trade journals, either. There are, no doubt, some computer hobbyists who own businesses, but they are no greater percentage of the small business community than they

are of the general population. The store which is waiting for eager business shoppers should begin looking for C.B. radio franchises. A virgin market awaits the store, which in conjunction with customizing/marketing consultants, can *go out to* the small business and offer turnkey systems.

However, the store's consultants should offer support in all peripherals of the sale: system design, software, marketing and service development, and financial resources (especially with established leasing firms). This is the direction we, at DATABASE, have taken as a result of small business critiques of the computer industry. So far, we have adaptable software in such areas as Hotel/Motel, General Retail, Medical, Wholesale Supply, and others. Our staff is composed of experienced professionals in System Design, Hardware Configurations, Programming, Field Engineering, Sales/Marketing, and Financial Resources. Perhaps not all store consultants will be this diversified, but stores would do well to find as many of these services as possible under one logo.

What then, can the independent computer store do to gain entry into this prime market? Adam Osborne, writing for the March 1978 issue of *INTERFACE AGE* nearly capsulizes both the problem and the solution: "Stores and manufacturers should sell standard products. When you deliver your product and get paid for it, the deal should be over. Leave all custom programming and hardware modifications to consultants." Osborne is also right on target when he states in the same article, "... so far as microcomputer systems are concerned, 1978 will go down as the year of the small business system." I am in wholehearted agreement on this point, but I would hasten to add the term *Turnkey*, and underline it.

In conclusion, we share Osborne's conviction that the computer store and the small business are natural kin, and that computer growth is dependent upon the small business market. The turnkey microcomputer has come of age, and forward looking computer stores have shifted their concentration from the leveling hobbyist market to this new bonanza. To put it bluntly, last year's dollars were worth more than this year's, and with inflation still our silent partner, if we're not growing (and at a healthy rate), we're shrinking. □

ABOUT THE AUTHOR

Neal Moran is currently General Sales Manager of Rimes DATABASE, Incorporated. Prior to joining the firm, Mr. Moran was President of M-J Associates, a retail consulting firm in management, marketing, and communications. He also served as Marketing Vice-President of M&M Electronics, a designer of custom alarm and communications systems. Mr. Moran still serves as Board Chairman of both these firms, which serve Illinois and Michigan retailers. □

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Considerations for Computer Implementation in A Small Business

Part 3 Selecting the Computer System Hardware

By Roger Williams
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INTRODUCTION

The purpose of this series is to provide guidance to the small businessman who is often unfamiliar with the complexities of computers. In Parts 1 and 2 cost factors related to implementation were presented with a discussion of the hardware requirements to create maximum affordability.

In this part the selection of the system hardware will be described in detail. Specific selection criteria for the chassis, Central Processing Unit (CPU), memory, controllers and the Input Output modules (I/O) will be presented. Also included is a discussion on the selection of peripherals: CRTs (Cathod Ray Terminals), printers and mass storage devices.

The selection criteria can be grouped into four categories of performance: *reliability*, *compatibility*, *capability*, and *expandability*. For business applications, *reliability* is by far the most important factor because down-time on the machine or errors in function can be costly and can have substantial indirect consequences as well. *Compatibility* is the next most important factor, which not only requires the hardware and software to function properly as a system, but also requires the computer system to be *compatible* with other systems and components in the business community. This is necessary in order to benefit from a wide hardware and software support base.

The *capability* of the computer system, of course, is the most obvious factor and reflects the reason for the existence of the computer in the first place. In the context of this article, *capability* will refer to those features which stand in addition to those involving *reliability* and *compatibility*. *Expandability* also is essential. The potential computer user almost always underestimates his needs of the near future, and he is wise to plan for economical expansion.

THE MAINFRAME

The mainframe is the part of the computer system normally understood to be the computer. It is the magic box which contains the chassis, the central processor or CPU, memory, I/O modules, and other mysterious modules such as disk and printer controllers.

Selecting the Chassis

The most elementary part of the mainframe is the chassis, often given only cursory attention in the selection process because of its simplicity. It serves no computing function, being simply a metal box together with the power supply and the slots into which a variety of individual modules or boards is inserted. But such simplicity is deceptive, and careless selection of the chassis may lead to sporadic and unreliable operation which is almost impossible to trace — and which is often incorrectly attributed to hardware and software problems.

The box, or cabinet, directly affects the *expandability* and *reliability* of the mainframe. Expandability requires that the number of slots for the modules be large enough to accommodate all possible future needs, including memory, controller, and special function boards. An extra bonus is that the chassis with a large number of slots also will have a greater unused power supply reserve and consequently more reliable and cooler operation.

The cabinet also should contain a fan to provide forced-air cooling. An operating temperature decrease of only a few degrees will double the average lifetime of most solid-state components, thus the fan could well increase *reliability* by a factor of 10 or more. It also should utilize an air filter to prevent oil or dirt deposits on components and contacts. Finally, for commercial applica-

tions, a simple panel with only a reset and power switch is preferable to the exotic front panel with switches and flashing lights. A power switch which is locked is recommended to prevent unauthorized access to valuable or sensitive data.

The power supply is another deceptively simple part of the chassis. It must be capable of supplying proper voltage and current to the complete set of modules, free of transients and noise from the AC line and from the modules themselves. This task may seem obvious and straightforward, but it requires both sufficient current capability and line filtering, together with special transformers. The current capacity needs to be at least one amp for each module slot, and constant-voltage or ferro-resonant transformers must provide some protection against line fluctuations and noise. A new type of special transformer, the "electronic tap changer," seems to be the most effective when used in conjunction with filtering of AC transients. The problem of the AC line irregularities is not just academic, and studies have revealed significant undervoltages and voltage spikes occurring on the average of 50-100 times per month. Such effects, resulting from conditions such as lightning, switching transients, and reactive loads, can be deadly to reliable operation of computers not having adequate protection.

The slots into which the modules are inserted also are simple, yet critical to reliability. These slots are all interconnected by a motherboard, which is merely a circuit board on which a large group of parallel wires is printed. Unfortunately, if these wires are not interspersed with ground wires to provide mutual shielding, they may have excessive crosstalk, especially with a CPU running at speeds above 2 Mhz. A lower-cost but less effective substitute for such shielding is the use of a ground-plane on one side of the motherboard to shunt noise to the ground. Additionally, the signal wires on the motherboard comprise a type of transmission-line which needs proper termination to prevent ringing and noise. Either insufficient shielding or improper termination can create erratic operation which is extremely difficult to diagnose. For this reason, some manufacturers will decrease CPU speeds substantially.

Finally, the motherboard has a specific bus structure, the physical format and logical definition for the wires on the motherboard. This bus structure determines *compatibility* to supporting hardware. All modules or boards currently needed and anticipated in the near future should be available from at least one supplier for the bus selected. Such needed modules may include memory, I/O boards, the CPU, printer and disk controllers, and special-purpose devices such as analog-digital converters and others.

Although one supplier, or single-source, is sufficient for each module, it is preferable that each needed module be multiple-sourced by many suppliers. This enables the selection of specific features and the economy of price competition, and most important, provides the security of future supply and servicing. An example of a bus which has both a large variety of modules to accommodate nearly every need, and multiple sources for each type of modules, is the S-100 bus. Unfortunately, this bus has no rigid and formal definitions of the signal lines, so manufacturers may use it inconsistently. Because of this, incompatibilities occasionally arise, and all manufacturers involved are best consulted independently to ascertain mutual *compatibility* of specific module combinations. Another example of a bus with a moderate variety of low-cost and multiple-sourced boards is the SS-50 bus. The MDS/Intellec and the LSI-11 bus structures also have a moderate variety of multiple-sourced boards, but these tend to be more expensive and

capable than is required in the small businesses. Two busses which are not yet widely supported for low-cost business applications are the Heath and IEEE busses.

Selecting the Central Processor, or CPU

The choice of the central processor, or CPU, frequently is based upon *capabilities* such as word size, speed, and "power." In reality, all processors, especially for business, are quite suitable in such terms inasmuch as business applications do not demand exalted performance. In fact, the CPU is idle most of the time, and response times are more influenced by characteristics of the mass storage units.

The most important aspect of the choice of CPU is software support, as evaluated in terms of *reliability*, *compatibility*, and *capability*. There must exist at least one piece of software capable of performing each of the needed non-custom tasks anticipated for both the present and the near future. Such software includes disk operating systems, compilers and interpreters for a variety of languages, applications programs, and software-development support for custom programming.

It is not enough that such software be merely available. It also must be reliable both in performance and in having sufficient documentation to permit effective use. Two types of documentation must be included: one type oriented to the end user with clear instructions, and the other type oriented to programmers to facilitate installation on the individual computer system and to allow error tracing.

Once it is established that the selected CPU is supported by such capable and reliable software, two conditions of *compatibility* are also important. The first condition is multiple-sourcing such that each requirement of software would be satisfied not only by one, but by a multiplicity of programs, to permit a large selection of characteristics and *capabilities*. This is especially important for applications programs and custom software-development programs, because different implementations of a given task can be handled with widely divergent techniques and costs. Different versions of a given DOS (disk operating system), or language will remain quite similar to each other. Additionally, multiple-sourcing of needed software is an indication of a wide selection of other software packages for the CPU.

The second condition of software *compatibility* is that each piece of software, once selected from the available pool, be used by a wide variety of additional programs. It is especially important for the disk operating system to be utilized by a wide variety of compilers, interpreters, and applications programs. Likewise, it is important for the compiler or interpreter to be utilized by a wide variety of applications programs.

Finally, although not directly affecting *reliability*, *compatibility*, or *capability* of software support for the CPU, is the cost factor. Software can be exceedingly expensive, and sometimes adequate capabilities may be achieved much more economically by changing the CPU involved. For conventional small business applications, a disk operating system, a compiler, or an applications program each preferably would cost under \$200, although some excellent and possibly necessary software would cost much more. Higher costs, if existing, are best spent for the underlying software rather than direct applications. For example, acquisition of a particularly compatible DOS or compiler might enable the use of a wide variety of inexpensive applications programs, thereby directly justifying the cost of the DOS. A similar argument can be advanced for costly custom software development packages which could save large amounts of expensive custom programming time for those ap-

plications which are not available in packaged form.

The 8080 and Z-80 CPUs have an especially wide selection of operating systems and languages. Some of this system software is so frequently installed in currently available systems that many, if not most, applications packages are written specifically for them — and such a situation is far more significant than the minor technical differences between processors. The 6800 also has a fair selection of software support. Other processors which have substantial and expanding software support are the 16-bit minicomputer chips such as the 9900, the LSI-11, the Nova, and the Alpha-Micro. The software for these processors is industrially oriented with high reliability and powerful capabilities, but most such software, with important exceptions, is also higher in cost.

The hardware capabilities of the CPU can be evaluated also in the context of recognizing their lower priority to software support. One feature is instruction power, which refers to the amount of calculation or manipulation which can be performed with each instruction, and which is especially useful for custom programming in assembly language. Another feature is throughput speed, which is a function of instruction power plus the cycle time, or speed of the CPU. For business applications, this may be useful in extensive string manipulations or in data handling. A third capability is hardware floating point, which permits calculations to be performed perhaps 100 times faster than with software, a feature oriented more to scientific computations than to business data handling.

Selecting the Memory

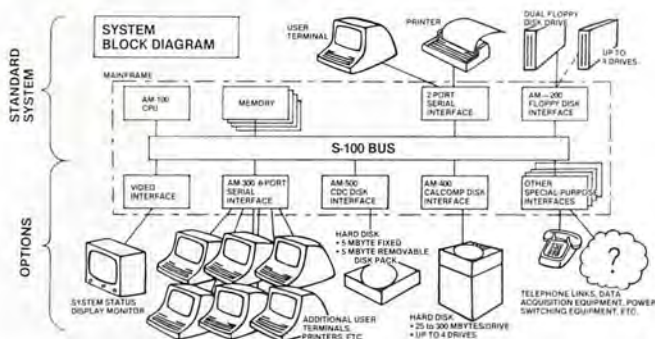
The memory frequently is the most expensive portion of the mainframe and must be selected with care in terms of *reliability*, *compatibility*, and *expandability*. Such care applies especially to the S-100 bus structure, although it also applies to second-sourcing any manufacturer's bus.

Reliability of the memory is affected by the manufacturer, the type, and the grade of memory chips used. Also important is the overall design of the memory boards, especially with respect to complete buffering for all data and address lines, both input and output, preferably with Schmitt devices. The chips must be prime, rather than the seconds as might be used by some hobbyist modules. Additionally important is the factory "burn-in", because most chip failures occur in the first few hours of operation. *Reliability* is greatly enhanced also by a hardware parity-checking feature built into the memory module so that it can detect most internal errors and notify the user.

Next most important is the *compatibility* of the memory modules with the other modules of the mainframe, especially with the CPU and disk controllers. Indeed, memory boards are the most vulnerable components for incompatibilities with bus line definitions, with CPU and disk-controller speeds and timing, and with CPU manipulations such as those occurring in time-sharing and DMA (direct memory access) operation. The memory should accommodate the full speed of the CPU type selected or likely to be used in the near future, either by utilizing selectable wait states enabling the memory to force the CPU to wait, or preferably by itself having a high speed. The most *reliable* and *compatible* type of memory is the totally static type, as opposed to dynamic types of invisible-refresh dynamic types. Static memory is generally well worth its slight extra cost, and specifically required in nearly all time-sharing and DMA environments. As with other types of modules, prudence dictates that all manufacturers be consulted for *compatibility* of specific memory boards with other modules.

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Expandability of memory is another consideration, especially in systems oriented to multiple users. The address space of the computer, which is the maximum amount of memory the CPU can access, usually is limited to 32K or 64K bytes but may be expanded through the use of bank-select or paging facilities built into the memory boards. The bank-select utilizes an I/O port to turn the desired memory board on or off, a function which also can be accomplished by utilizing additional address lines on the bus. Ideally, the memory boards would have the capability of using both techniques.

The amount of memory required for the average single small business user generally runs about 48K to 56K bytes. The operating system requires 8K to 16K, the interpreter/compiler requires 12K to 24K, and the applications program may require at least 20K. Since one user alone may need most of the address space, the need for bank switching is seen clearly for an environment of multiple users where each might need different compilers and applications programs.

Selecting the I/O Modules

The input/output modules require two basic types of *compatibility* — that of software and hardware. Software compatibility is not considered here because an incompatibility often exists and must be adjusted by the supplier or by the consultant. Hardware compatibility is an important selection criterion, especially with reference to the peripheral devices utilized.

Hardware I/O occurs in either parallel or serial format. Parallel format may assume latched or unlatched operation, and some peripherals require one or the other. Also, some computer configurations depend upon the I/O board to generate "hardware interrupts" or even to process them.

Serial formats may occur in either synchronous or asynchronous modes with a variety of speeds or baud rates. Some peripherals and mainframes require that serial boards provide handshaking which enables the computer or peripheral to request permission to send data before it actually does so — in contrast to most serial I/O which merely blasts the data down the cables whether the target device is ready or not. Many boards do not provide for such handshaking. The I/O board must also be matched to the processor clock for properly timing the serial data rates, although some boards will provide their own on-board crystals to eliminate such dependencies and matching requirements. As with parallel modules, serial modules also may need to generate hardware interrupts to the computer system. Additional useful features in serial I/O modules are the ability to set certain parameters by software, including those such as baud rate, parity, and the number of start bit and stop bits. If it is desired to operate a CRT terminal at maximum speed, the module needs to be capable of asynchronous operation at 19,200 baud rather than the limit of 9,600 baud with most boards.

It is not important that the businessman understand these terms, but instead that he understand the fact that these technical aspects must be considered carefully by someone — at least by the person or supplier creating the system. An example of a common slight mismatch is the unnecessary limitation of CRT speeds to 9,600 baud by using a board incapable of the usual CRT speed of 19,200 baud.

Selecting the Controller Boards

The controller board, such as a disk, tape, or printer controller, resides in the mainframe physically separate from the peripheral unit controlled. As with other modules, certain *compatibilities* of the controller board to

the mainframe must be ascertained, especially with regard to the specific brands of memory and CPU modules. It is vital that the manufacturers involved be contacted, especially with concern for the use of bus lines, for the speed of the CPU, for the speed and type of memory, and with special attention to timing and DMA aspects. The controller unit usually, and preferably, is supplied with the peripheral unit as part of a complete package. If the controller is not thus packaged, the interfacing between the peripheral unit and the controller is best left to a professional.

Controllers, especially disk controllers, also must be compatible with the world outside the computer and with the software needed by the business. Each disk controller, for example, is designed to utilize a specific type of sectoring on the disk, usually hard or soft sectoring. It is essential that this sectoring be compatible with the design of the desired disk operating systems, compilers, and applications programs.

Two sizes of disks, mutually incompatible, exist — the mini floppy and the normal-size floppy, each having both types of sectoring. Many controllers can accommodate only one size of disk drive, thus, in addition to sectoring, the size accommodated must match the media on which the desired software is exchanged and for which the software is designed.

Finally, the disk controller should have an on-board PROM containing a program to enable loading the disk operating system into the computer without hassle, and this PROM must not interfere with concurrently running software such as the DOS itself, the compiler, and applications programs.

Reliability of disk storage is perhaps the most important aspect affected by the choice of disk controller, even if the controller itself were to function totally reliably. Disks are imperfect media subject to a variety of error sources. The use of "single density" formats for recording the data on the disk is the most reliable, and double or quadruple density formats are especially vulnerable to dirt, misalignment of heads, speed variations, wear on the heads, and wear on the disk.

The controller also might incorporate a variety of error detection and recovery mechanisms. The most elementary is the CRC error checking technique. For business applications, if the CRC check is not made in the controller itself, then it is essential that it be done in the operating system. Another important feature is an automatic retry to make multiple read attempts on information found to be in error by the CRC. The most sophisticated controllers may incorporate error-correction codes to recover data which cannot be recovered merely by multiple retries.

These factors of *reliability* and *compatibility* are the most important ones for disk controllers, but *capabilities* are not to be ignored. The *capabilities* of the disk system affected by the controller include data storage capacity, speed of data transfer, and freedom permitted to the CPU during disk operation. The storage capacity is most relevant for business, and is increased if the controller can accommodate double-sided drives which double storage capacity without the compromise of increasing recording density. The controller also needs to be capable of handling at least three or four drives, preferably accommodating both the mini and normal size drives.

Although the speed of access to the drive generally is not affected by the controller significantly, the effective speed of data transfer may be increased if the controller can provide DMA. Finally, the freedom extended to the CPU is derived from two controller capabilities — interrupt and DMA. The interrupt feature, usable only if such

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interrupts are supported by the mainframe, allows the controller to search for the desired data without tying up the CPU for long waiting periods, then to notify the CPU when the access is completed. The DMA feature allows the actual data, once located, to be transferred to memory without requiring the CPU.

Some controllers also are "intelligent", in that they have a self-contained CPU and disk operating system. This reduces memory requirements in the mainframe for the DOS, and also may extend additional freedom to the mainframe CPU by not requiring its services to locate the desired data on the disk. The effectiveness of this additional CPU freedom depends upon whether interrupts are generated and supported by the mainframe, and upon the interrupt and DMA capabilities of the controller itself. One possible disadvantage of the intelligent controller is a reduced flexibility in choice of DOS and limited program access to hardware details of the controller and disk drive.

Selecting Other Boards

Other modules or boards may have idiosyncrasies when used in certain mainframe combinations, as emphasized before for memory and controllers. They are best checked out with the manufacturers involved, or by actual demonstration of an identical working system. No problems will exist 90% of the time, but often a few phone calls can prevent major headaches later.

THE PERIPHERALS

The discussion of peripherals is digested much more easily than that on the mainframe since peripheral specifications relate to more familiar measurements and more visible results. They, in contrast to the mainframe, are not so mysterious, as everyone understands the functions of devices such as the CRT terminal, the printer, and the mass storage units such as the disk and tape.

Selecting the CRT Terminal

The CRT terminal provides the communications link between the computer and the operator, and consists of a TV-type display for text and graphics, plus a typewriter-style keyboard. There are two major aspects to consider in its selection — the human and the technical.

The human aspect of CRT capabilities is important because the operator may be sitting for long periods at the terminal, entering data and reading the display. It is essential that the terminal, and indeed the whole workspace, be comfortable and efficient. The display must be at least 12 inches diagonal, clear and sharp across the entire screen, and the characters must be easily readable, preferably with resolution better than the usual 5x7 matrix, such as 7x10, 9x12, or other dimension dot matrix. A fuzzy, wandering, or vibrating display with coarse characters can create substantial discomfort and eyestrain. Additionally desirable are glare-free screens and comfortable viewing angles.

The keyboard should have a positive feel, a separate numeric keypad, and possibly even a separate cursor pad, especially if much text editing is anticipated. Indeed, a keyboard without at least the separate numeric pad is inappropriate for the constant numerical entry of business data. Special function keys which may be custom-assigned for each implementation are similarly useful. Detachable keyboards allow adjustment of seating positions to accommodate working documents and writing while entering data. A bell or tone to allow the computer to call for the attention of the operator is also useful.

Other human factors are more technical and involve compatibility with external standards. One example is that the screen should contain at least 24 lines of 80 characters, which is an industry standard for both CRT terminals and for printers utilizing 8½ inch paper widths.

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Terminals used for large amounts of text editing may benefit from displays with 48 lines of 80 characters to accommodate nearly a full typewritten page. Both upper and lower case must be available, and lower-case letters should have descending tails on letters such as "g", "j", "p", "q", and "y" — to be compatible with standard writing and reading practice.

Another feature of the CRT terminal is the use of protected fields, which are regions on the display, usually signified by reduced intensity, into which the user cannot write. These simulate, and are compatible with, the conventional printed form which is designed to collect data, whereby the desired data is inserted into the "blanks" or unprotected regions of the display. Such fields enable the rapid collection of data without the usual sequence of prompts and answers — which are often difficult to read and do not enable simultaneous display of large amounts of data.

A less important *capability* of the CRT terminal involves dual intensity, which is useful for highlighting desired data or text blocks, preferably independently of protected fields. Another form of highlighting is reverse video, whereby selected portions of the display may be written with black on white instead of the usual white on black.

Certain considerations are important to allow future *expandability* to operations which are not essential for business applications initially, but may be useful in the future. One such feature is the use of different character sets such as foreign languages or technical symbols on the CRT. Another related feature is graphics capability to produce charts, graphs, diagrams, or other displays. And finally, in some applications, it is useful to have an extremely fast display function in real time, without the limitations of the conventional 19,200 baud of most terminals. If these capabilities are anticipated to be important, then CRT terminals which can accommodate them should be considered.

Additional, and somewhat technical, features of the CRT terminal refer to the terminal-to-computer communications link, which influences *compatibility* with some types of software as well as general capabilities of the CRT. Some programs require that the CRT have an addressable cursor (a cursor indicates where the next character will be written on the screen) which enables the program to position the cursor anywhere on the screen. Some programs also require cursor sensing to enable the program to ascertain its location on the screen. Both are essential for text editing programs and almost essential for efficient data-collection techniques such as those using protected fields. Related to cursor addressing and sensing is the additional capability of character sensing at the cursor, whereby the program can ascertain not only the location of the cursor, but also the character residing at that location.

The CRT terminal also can have non-essential capabilities for communicating with the computer. One such feature is block mode transmission of display lines and pages to the computer in addition to the conventional character-by-character transmission. This permits editing on the terminal without the use of the computer, and is especially useful in time-sharing applications. Another useful feature is automatic tabs and editing modes. Some terminals also provide printer ports for direct copying onto a printer, again reducing the load on the computer and interconnection complexity.

Certain highly technical specifications are important for proper matching of the terminal to the I/O modules in the computer mainframe. These include references to the type of interface such as RS-232, or 20 ma current loop, and references to the speed of communication or baud rate (which should extend to 19,200 baud for CRT terminals), and to the communications protocols such

as parity, duplex or half-duplex, and number of start and stop bits. The businessman need not concern himself with these specifications, provided he has a professional assemble the system such that it works satisfactorily.

The CRT terminal with keyboard, (or detachable keyboard), usually is configured as an entity entirely separate from the computer, connected to the computer by one thin cable which may be 10 to 50 feet long. Some of the lower-cost systems, however, may be configured with the terminal separated into three parts consisting of a video monitor, an electronics module installed in the computer mainframe, and a keyboard — all with separate interconnecting cables. These have the advantage of slightly lower cost and certain types of *flexibility*, such as graphics, alterable character sets, and the higher speed of a possible memory-mapped display. These advantages generally are not important to the small business, although there are exceptions as discussed earlier. The unified terminal has an advantage in that it is conceptually and cosmetically clean, and may be easily located remote from the computer, which is especially useful in multi-terminal systems.

Selecting the Printer

The printer is one of the most essential peripherals in a small business system, and also is one of the most difficult to select. In addition to being the vehicle of data output, the printer also is the typewriter for text-processing, the vehicle of program listings, and the fundamental means of backup record-keeping.

Just as with other hardware, the *reliability*, *compatibility*, and *capability* of the printer are important selection criteria. These can be applied to different aspects of the printer, such as the size and type of paper stock, the format of print lines and print characters, the handling of paper and forms, and the interfacing to the computer.

For reasons of economy and convenience, the paper stock used by the printer should be standard-width conventional notebook paper or computer paper, rather than the specially-sized or coated papers required by nearly all non-impact printers. An exception would be where ultra-quiet operation or other special capabilities are overriding factors. The printer should be capable of making multiple copies, thus requiring an impact type of print mechanism, and the print line should accommodate at least 80, and preferably 132, characters.

The format of print characters is especially important for readability and flexibility. Most useful is an upper and lower case character set which, in fact, is essential for any text-editing or text-producing applications. Another feature, also valuable for text-editing applications, is the availability of interchangeable fonts for different styles or special character sets, such as those for technical applications. An ability to produce bold-faced or double-width characters is desirable, as is also a *capability* to generate charts, graphs, and diagrams. And finally, bidirectional printing can increase printing speeds substantially by eliminating the waiting periods of carriage returns.

An often overlooked feature in printers is the paper and forms-handling *capabilities*. A pin-feed feature is essential for business applications, so that correct registration of preprinted forms may be maintained without constant adjustment. The pin-feed also permits multiple copies to be controlled more easily than does the conventional friction-feed mechanism. The spacing between the pins should be adjustable to accommodate a variety of paper widths, with a total paper width ranging from a few inches to at least 9½ inches and possibly to 15 inches to accommodate the 132-character standard computer printout widths useful for tables and reports.

Other useful paper-handling features are horizontal and vertical tabs and an out-of-paper switch. Tabs cause both print head and paper positioning to occur much more quickly and conveniently than the incremental character-to-character or line-to-line motions necessary without the tabs. Printed forms handling features similarly facilitate print head and paper positioning in accordance with specific forms lengths, widths, formats, and positions. The paper alarm, if connected as a shut-off switch to the computer, is valuable for performing long printing tasks without constant supervision by the operator.

Another evaluation criterion applicable to all printers, primarily affecting various type of compatibility, concerns the printer-to-computer interface. In order to match the I/O modules, there are two basic types of interfacing, parallel and serial. The serial interface is preferable, because it is compatible with most computer systems, especially in the form of the RS-232C option, whereas parallel operation is generally formatted differently for each printer. The serial interface also is compatible with a wider variety of software, and simplifies custom interfacing to those printers with sophisticated features such as incremental spacing, tabbing, and forms control. It additionally simplifies the cabling requirements to the printer, especially if the printer must be remote from the computer. If serial operation is utilized, it should be capable of a baud rate considerably higher than the printing speed to ensure that long strings of control characters, which are not printed, will not reduce the actual printing rates.

Another requirement of interfacing *compatibility* is that the character code used by the printer be ASCII, rather than a variety of other codes. This standard is worldwide, used by nearly everyone. Additionally, for either serial or parallel operation, certain handshaking protocols, as discussed with I/O modules, may be necessary.

Some printers also contain keyboards, enabling their use as remote terminals. This may be especially convenient in a time-sharing system if the printer is free part of the time for terminal use, saving the expense of another CRT terminal. A keyboard also will enable printer control directly from the printer location, useful if the computer is remotely located. An extra feature of some printers is a bell to notify the operator of special conditions.

There are two basic types of printers fulfilling the preceding requirements of *compatibilities* and *capabilities*. One type is the solid-character printer which creates typewriter-style characters, usually by means of a rotating ball such as the IBM Selectric, or by a rotating disk or daisy wheel. The second type is the dot-matrix printer which forms characters by an array of dots. Other types of non-impact printer mechanisms exist, but these omit at least one of the preferences discussed earlier.

The solid-character printer usually is slower and more expensive than the dot-matrix type, but is required for text-editing applications such as correspondence, legal documents, and manuscripts. The least expensive printers, costing \$1,000 to \$1,500 are similar to typewriters, with speeds not exceeding 15 characters per second, or 3½ to 6 minutes per page, and with no graphics or proportional spacing features.

The sophisticated units, costing \$2,500 to \$3,500 are exceedingly capable, and have speeds up to 55 characters per second to produce one page in ¾ to 1½ minutes — faster than the slowest of the dot-matrix types. One important feature is proportional, or incremental, spacing, whereby the characters may be moved horizontally or vertically in units of ¼, ⅓, or even ⅕ of an inch. This permits a true right justification which does not require multiple spaces between words, and which facilitates subscripts, superscripts, and bold characters — in

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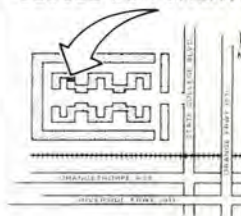
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Certain *reliability* criteria are especially applicable to the solid-character printers. One of the most essential features in any printer is overrun protection, such that attempts to print characters past the end of the line will not damage the mechanism. Another feature, technically called closed-loop operation, enables the printer to request each character at times exactly optimized to minimize wear and errors. This criterion is most frequently ignored in some adaptations of the Selectric. A third *reliability* feature is simplicity and design integrity. The simpler mechanisms have less to go wrong, and design integrity requires heavy-duty mechanisms which are capable of continuous duty — also relevant to the Selectric adaptations. For the daisy-wheel printers, the use of a metal character disk is sometimes preferable to the plastic disk.

In addition to *reliability*, certain *capabilities* also are important for solid-character printers. One is the capability to use film ribbons which produce superb print quality for creating masters. Another capability is a pitch selectable between 10 and 12 characters per inch, which is not necessarily included even with printers with incremental spacing features.

The dot-matrix printers vary widely in speed, print quality, and cost. Units costing \$1,000 to \$1,500 usually will have some compromise. For example, one unit might have excellent print quality but slow speed, another might have only marginal print quality with medium speed, and another might have upper-case only with medium speed. Units costing \$1,500 to \$2,500 may be excellent on all counts, with speeds upwards of 120 to 180 characters per second, corresponding to a page every 17 to 28 seconds. One goal is to achieve the maximum speed/cost ratio consistent with *reliability* and necessary *capabilities*.

As with the solid-character printers, certain factors are specific to the dot-matrix printers. *Reliability* is affected by the maintenance of print quality of the head, especially after many hours of operation, and especially is apparent with lower-case characters. All dots must be impressed equally and forcefully, without smearing. The character spacing and printed lines should be even, without characters jittering about. The ribbon also should be capable of providing large numbers of characters, since the dot-matrix printer is used for volumes of printout. This requires special construction and inking arrangements.

The most important *capability* of the dot-matrix printer is, of course, the design of the characters in terms of readability. As with CRT terminals, they should be high resolution, preferably more than the usual 5x7 matrix. The lower-case characters should have descenders for readability, although this may not be possible with low-resolution matrices. For this reason, it may be difficult to find low-cost dot-matrix printers with lower-case descenders.

Other desired capabilities of the dot-matrix printers are selectable pitch, horizontal and vertical incremental spacing, and interchangeable or selectable character sets. Many printers will accommodate not only the 10 and 12 characters per inch of typewriters, but also higher or lower densities for generating large-character titles and headings, or for compressing 132 characters onto the standard 8½ inch page. The character sets of some printers may be changed merely by changing memory PROMs in the unit. The horizontal and vertical incremental spacing capabilities are not necessarily included with dot-matrix printers, contrary to popular belief, and in fact are seldom available in the lower-cost

varieties. When these are available, however, spectacular graphics and multi-shade imaging is possible because the resolution of dots in the dot-matrix is much higher than possible with solid-character printers.

Selecting the Mass Storage

Mass storage is perhaps the most mysterious and most sensitive selection for the computer system. Mass storage is the vehicle by which all programs and data are stored, with only the minor exceptions of PROM and ROM, which are small amounts of memory in the main-frame which will not forget when power is removed. Mass storage may take a variety of formats ranging from paper tape and audio cassette to large-capacity hard disks and possibly magnetic bubbles, and it may range in capacity from a few tens of bytes to over a thousand-million bytes.

The small business need be concerned with only a few types of mass storage — digital tape cassettes, floppy disks, and possibly hard disks. The other types are either cumbersome, unreliable, or too costly. The digital cassette is most useful for sequential storage and retrieval, whereby programs and especially data are arranged in a linear sequence on the tape. The sequence usually is based upon numerical or alphabetical order applied to a quantity such as date, name, or number — or in some cases, may be based only on the order in which data was written onto the tape. Access to sequential data normally requires reading all the data until the desired data is recognized.

The digital cassette has the advantage of economical storage capacity exceeding 1 to 2 megabytes for a \$500 to \$1,000 investment. The disadvantage is slow reading speeds and extremely slow search speeds, exceeding 20 to 40 seconds to locate a particular entry, even in the more sophisticated units.

The floppy disks are much faster than the digital cassette in both read and search speeds. The read occurs at 10 to 50 times that of the digital cassette, and access time is less than ½ second instead of the 20 to 40 seconds of the cassette. The overwhelming advantage of the floppy disk, in addition to faster operation, is the availability of random-access operating systems. The data, in even small units, may be stored on the disk in any physical location and may be retrieved directly, without reading or referencing the data itself, as required in sequential access. A limited form of random-access also is possible with the digital cassette, but the linear format of the tape, as opposed to the two-dimensional form of the disk, severely limits the speed of such direct access.

These two *capabilities*, random-access and direct-access, are worthy of clarification, since the two words frequently are used interchangeably and may obscure certain limitations of disk drives. True random-access is an access to a particular data set without physically traversing other data sets. In this sense, a RAM memory has true random-access capability, but the floppy disk does not. The floppy disk mechanism consists of a head which physically and sequentially traverses multiple concentric tracks on the disk, and then the disk must rotate a number of sectors sequentially under the head until the desired sector appears. Physically speaking, the disk is a two-dimensional sequential-access device functioning quite similarly to the one-dimensional sequential access tape cassette. Indeed, a stack of multiple electronically-selected tape cassettes would be true random-access in one dimension, and sequential in the other.

Logically, as opposed to physically, the disk may be seen as a true random-access device in which the details of physical operation are hidden from the pro-

gram — this, in fact, is a primary function of a disk operating system. In this sense, the data is accessed directly with an address or location known by the DOS, and the data itself need not be read to be located. This may be called direct-access or, more loosely, random-access. In this sense, though, the tape cassette also may qualify as a random access device, since a cassette operating system could define addresses or sectors on the tape as well as a DOS could.

The essential difference, then, between disk and tape is the two-dimensionality of the disk, and the speed of sequential traversal of intervening data. Both disk and tape, with a suitable operating system, can be random-access or direct access devices, and neither are true random-access devices in the physical sense.

One disadvantage of the floppy disk is limited storage capacity, with less than 80 kilobytes (16 to 30 typewritten pages) on most mini-floppies, and about 250 kilobytes in the standard-size floppies. This limitation is mitigated somewhat with the new developments of double-sided and double-density units, but still will remain 3 to 6 times as expensive per kilobyte as the digital cassette.

The more sophisticated disk operating systems permit variable-length data regions or files to be specified during program execution, enabling efficient use of the disk space. The most sophisticated operating systems create the effect of the disk functioning as a virtual extension of the addressable memory within the computer, eliminating the need of physical files, records, and so on.

The hard disk, in contrast to the floppy disk, is the most sophisticated — and the most expensive and delicate — form of mass storage. Hard disks can read data 5 to 10 times faster and can access data 10 times faster than the floppy disk, even with storage capacities exceeding 100 to 1,000 megabytes. The operating systems for such units can be extremely capable, and are most effective with fast CPUs, although some hard disk systems can survive on floppy disk software. The disadvantages are that hard disk systems are quite expensive, costing from \$6,000 to \$50,000 or more, and are justified only when large volumes of data must be on-line with instant access, rather than the slow access of multiple digital cassettes or the non-instant operation of exchanging multiple floppy disks. Hard disks also have the disadvantage of being extremely sensitive to shock and handling. Backup of non-removable hard disks is costly and must be achieved by a complete duplicate disk drive, or by the removable disk packs available on some drives.

Mass storage, as all other components, can be evaluated in terms of the magic four words: *reliability*, *compatibility*, *capability*, and *expandability*. The capabilities of different forms of mass storage were described briefly in the foregoing in preparation for detailed evaluation of each type.

The two types of tape cassette — audio and digital — are the least expensive type of mass storage, and as implied before, only the digital version of cassette is sufficiently reliable and capable for business applications. For maximum *reliability*, digital cassettes should utilize a recording technique which is insensitive to speed variations of the tape, both in record and playback. It should also utilize the CRC error-checking capabilities described earlier in the section on controllers, as well as the automatic retries and error-correction schemes also described.

Compatibility is not an important issue with cassettes, as there are virtually no widely-used standards — at least in the low-cost business systems. For a minimum *capability*, the digital cassette must be software controllable for fast-forward and rewind with provision of marking inter-record gaps, or sectors. A mere



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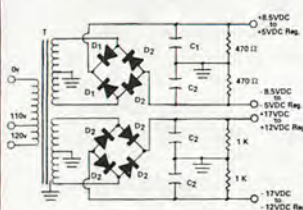
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on/off feature alone is hardly sufficient. Additionally, a truly adequate cassette operating system requires capabilities approaching those of a good disk operating system, but this is nearly impossible to find at low cost. And finally, the digital cassette should be capable of completely searching the cassette in 20 to 40 seconds and of reading or writing data faster than 20,000 to 50,000 baud. Slower data rates tend to be exasperating in business applications.

The floppy disk is the most widely used mass storage in business systems, and is the most appropriate compromise between storage capability, access and read speeds, and cost. With the disk drive, *reliability* is the most essential factor — a dropped bit can cause the complete destruction of data on the disk and therefore be a disaster, especially if inadequate backup procedures exist. Any choice involving a tradeoff of *reliability* is to be avoided — even though gains in performance can be highly seductive.

One requirement for *reliability* is that the record/playback heads contact the disk only during access and data transfer, and lift away otherwise. The heads should create minimum pressure on the disk during use, to reduce head and disk wear — and drives differ by a factor of two or three in this respect. Mechanical stability of the head mechanism is also important, as is tolerance to misalignment and misadjustment. *Reliability* of the manufacturer in supporting the drive with warranty and later service is essential, and some drives do not have ideal support. Maintenance is important, as the user must beware of using misadjusted drives to keep business data. The danger is that a misadjusted drive may function apparently well — until the point where it must fail. If the subsequent adjustment causes too large a correction, then the data originally recorded on the misadjusted drive may be irretrievably lost. Another reliability-enhancing feature is the use of a positive-pressure environment in the drive to prevent dirt and dust from entering the drive and the disks.

Proper selection and care of the disks themselves also is a must. Only the highest possible quality disk should be used, as ascertained by asking other users and suppliers, and then these disks should be verified against dropouts. Any extra costs would be trivial compared to the costs of losing data, even with adequate backup. The disk surface never should be handled by the fingers, and the disk must be kept in a nearly airtight and dust free container. Since the disks are magnetic media, care also must be taken to keep them away from magnetic fields, including those of power transformers in the computer, printer solenoids, CRT terminal, and even AC wiring embedded in walls. Carelessness with quality and handling of the disk itself is one of the more common sources of problems which are incorrectly attributed to a host of other factors.

A short note of caution is appropriate regarding disk systems relating to *compatibility* and *reliability*. Disk drives sometimes are sold separately from the controllers, which in turn are sold separately from the mainframe, CPU, memory, and I/O modules. Sometimes one of these items has some incompatibility with the remainder, so it is advisable to purchase a system either pre-packaged or assembled by a professional, or at least to make certain that the drive and controller are packaged together.

Closely matching reliability in importance are considerations of *compatibility* with regard to disk size and formatting. Although the hard disk may have no obvious *compatibility* issues, the floppy disk has important ones. There are two sizes of floppy disks, the 5¼ inch mini-floppy and the 8 inch normal-size floppy. Each disk size additionally utilizes two types of sector-marking techniques, the hard-sectoring and the soft-sectoring,

both mutually incompatible. The most common and compatible type of disk is the 8 inch version which is soft-sectored and which is recorded with single density in the IBM 2740 format. Most operating systems, compilers, applications software, and custom software development packages both are designed for use with disk drives using this format, and are supplied on disks in the same format. Thus any choices of either hard-sectored or mini-disks must be evaluated most carefully for *compatibility* in both respects. For example, a desirable DOS or language might be adapted to an alien disk size or sectoring format, but there is no guarantee that the applications programs using the DOS or language also would be supplied on the same alien disks.

An obscure DOS or compiler can be quite costly, because conversion of complex applications programs to such a DOS is not a trivial task and may be totally impossible if the applications program is not supplied with the source code, as most are not.

The capacity of the standard-size disks can be doubled by using the double-sided versions, which requires a special drive and possibly special controllers. A dual double-sided disk drive with IBM format will store over one million bytes without compromising *reliability* by increasing density, as discussed earlier. The double-sided dual mini drive would have about 250 kilobytes storage under similar conditions.

Frequent mention is made of the access speed of the disk drive. It is important to note that average access time is comprised of the sum of two separate time delays — the seek time for the head to travel radially to the desired track, and the latency time required for the disk to rotate to the desired position. Since the disk rotates at the same constant RPM for all floppies of the same size, the average latency time also is a constant which tends to reduce the advantages of high-speed

Only after these factors of *reliability* and *compatibility* are satisfied is hardware *capability* of the disk important. For business applications, the floppies are essential to avoid excessive waiting periods for program retrieval and data access. In addition, the *capabilities* of dual floppies are an absolute essential, either in the form of mini-floppies costing \$1,000 to \$1,600 or standard floppies costing \$1,500 to \$3,000. The dual drives provide backup disk copies of vital business records, and they enable separation of program disks and data disks to reduce confusion and risk of destroying data and programs.

Also, the use of standard-size floppies is highly recommended, since the mini-floppies usually will have insufficient capacity for most business needs. Even dual standard floppies are insufficient for large amounts of data such as required for complete on-line audit trails, in which all data is immediately available without changing disks. An example might be the listing of all invoices, complete with itemized detail, for a quarter of a year. Such data normally would be kept on several disks. One economical means of achieving true on-line operation would be a combination of floppy disks and digital cassettes, creating a system certainly not as fast as the hard disk, but nevertheless quite powerful.

seek times. The end result is that a ten-fold increase in seek speeds may well improve average access time only by a factor of 1½ to 2 — especially if the accessed tracks are clustered together.

The foregoing has concentrated on the hardware aspects of disk drives, but the software support for the selected disk drive is also important — in much the same way as the software support discussed earlier for the choice of CPU. Most important are the *compatibility* and *capability* of such software, and the most vital software is the DOS and compiler — although applications programs and software-development packages also are affected.

At least the DOS, and possibly the compiler, must be supplied as part of the disk drive and controller, otherwise costly custom modification by a consultant may be required. For this reason, the characteristics of the supplied DOS and compiler must be evaluated carefully, and can determine the choice of disk drive. The DOS and compiler, or interpreter should be checked for *compatibility* with other hardware components in the main-frame and peripherals, especially with regard to memory assignments, interrupt operation, and I/O port assignments and protocols for the peripherals. Again, the avoidance of costly custom modifications is the issue.

Adequate *compatibility* also requires that both the DOS and compiler are widely used by available applications programs and custom software development packages, especially those programs which are needed by the business. An obscure DOS or compiler can be quite costly, because conversion of complex applications programs to such a DOS is not a trivial task, and may be totally impossible if the applications program is not supplied with the source code, as most are not. Additionally, the DOS alone should be utilized by a large variety of compilers and interpreters.

The packaged DOS and available languages and programs also need to be capable and powerful. The DOS is expected to support extensive random and sequential access to both programs and data, and preferably would support indexed sequential accesses as well. File handling and manipulation capabilities should be complete, and a wide variety of utilities should be included, such as text editors and assembler. The supplied compiler also needs to be capable of fully utilizing these DOS capabilities, and in general, the available applications and development software which utilizes the DOS and compiler must be capable of performing the tasks required by the business.

Such software attributes are examined in great detail in the next part on software selection. The important point is that the choice of disk drive determines a whole chain of software support starting with the DOS, and extending through the languages to the applications and development programs — each of which must be suitably linked with supporting software or the CPU, and each of which must be suitably powerful and capable.

The criteria for evaluation and selection of software to complement this part on hardware will be discussed in Part 4. The disk operating system will be discussed in detail, together with the programming languages. Important factors for selecting standardized applications packages will be presented, and procedures and evaluations involving custom system analysis will be examined. □

Comments regarding this article can be sent to INTERFACE AGE, P.O. Box 1234, Cerritos, California 90501. The editors will publish as many letters as possible. Letters directed to Mr. Williams will be forwarded to him by the magazine.

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Computer Tutorial

Charge-Transfer Devices and Magnetic

By Roger Edelson, Hardware Editor

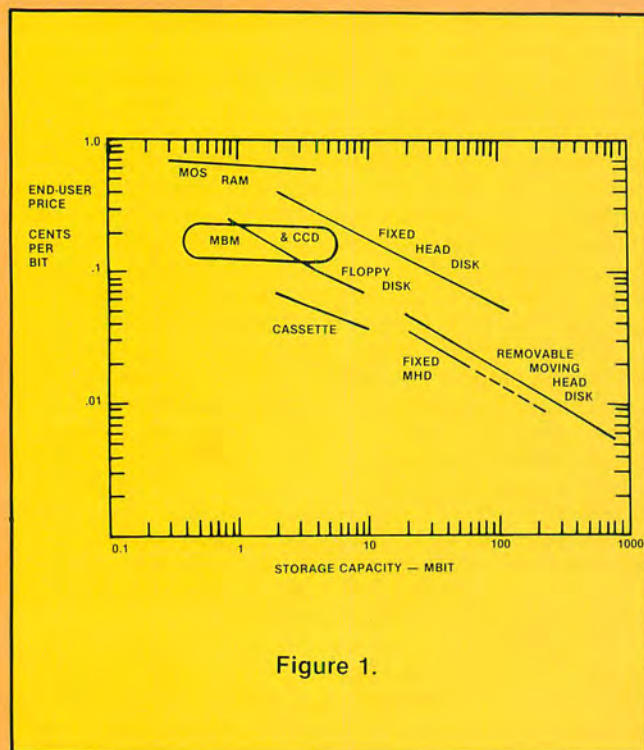


Figure 1.

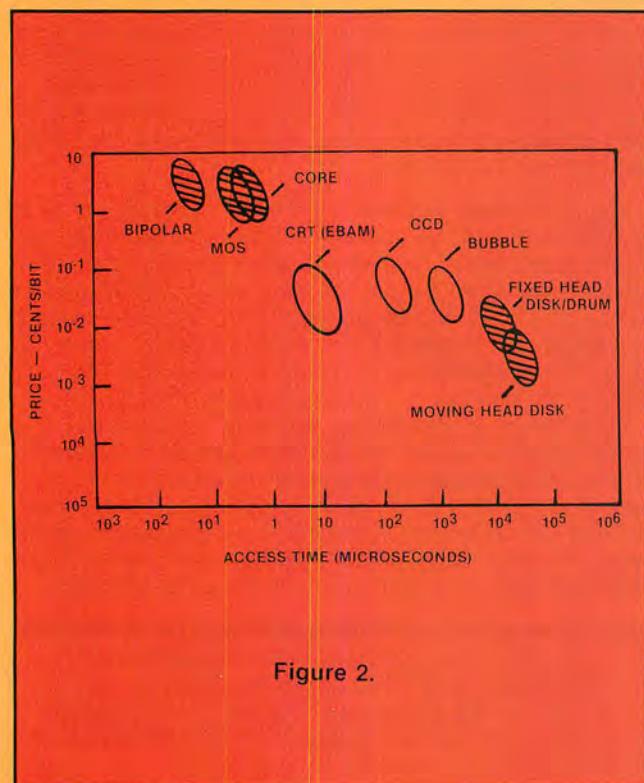


Figure 2.

This month the Computer Tutorial will discuss large capacity, block organized, random access memories (BORAMs). Of particular concern are the charge-transfer devices and magnetic bubble memories (MBMs) which are, to some degree, competing technologies.

The MBM provides non-volatility and a higher packing density, but CCDs have a faster access time and a higher transfer rate. The price per bit of both devices is approximately the same.

Let's begin with a discussion of the MBM; its major advantages over most other competing technologies are non-volatility and a low cost per bit. Figure 1 illustrates this price versus capacity comparison. Figure 2 illustrates the position of the MBM in comparison with other storage technologies on a price versus access time basis. As can be seen, the MBM is somewhat faster than the disk/drum devices but is many orders of magnitude lower than the more normal RAM techniques. The MBM, however, does not provide the media removability of the floppy disk devices.

Magnetic bubble memories are implemented by growing an epitaxial layer of magnetic garnet on a non-magnetic substrate — G^3 (for gadolinium gallium garnet). Since it is desired that the formed bubbles be controllable, the hard bubbles must be suppressed. This is done by ion-implantation of the magnetic garnet. Spacers, conductors, and magnetic patterns are then placed on the device, and the chip is then placed between two permanent magnets whose flux is perpendicular to the garnet sheet. Magnetic domains within the sheet are therefore aligned in the direction of this external field. The action of the perpendicular magnetic field tends to shrink those magnetic domains polarized opposite to the external field. As the field becomes stronger, the domains shrink until they become small cylinders in a larger mass of opposite magnetic polarity. These cylinders, when viewed on end, have the appearance of small circles — hence the name "bubbles." The size of these bubbles is dependent on the strength of the applied field. If the field strength is increased beyond a certain amount, the bubbles will disappear because the entire garnet will line up with the direction of the applied magnetic field. In this case the bubbles have been "annihilated."

Once these bubbles have been established, and stabilized, it is necessary to move them around in order that some practical use be made of them. The various processes required consist of generation, propagation, detection, and annihilation. Where the memory is to be organized as a block storage device, as in the example we will present later, it is necessary to include the processes of replication and transfer.

Bubbles are generated by a small loop of wire which produces a current loop above the garnet surface. This hairpin shaped device is called a nucleate generator. The bubble is produced by the localized field set up when a current is introduced into the wire.

Propagation is performed through the use of a rotating magnetic field in conjunction with permalloy mag-

— Memories

Bubbles Or — Buckets and Bubbles

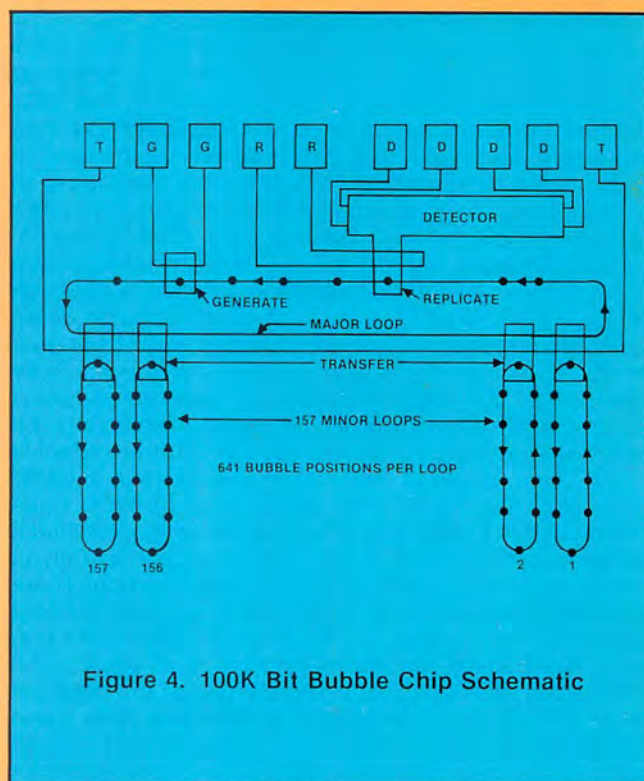
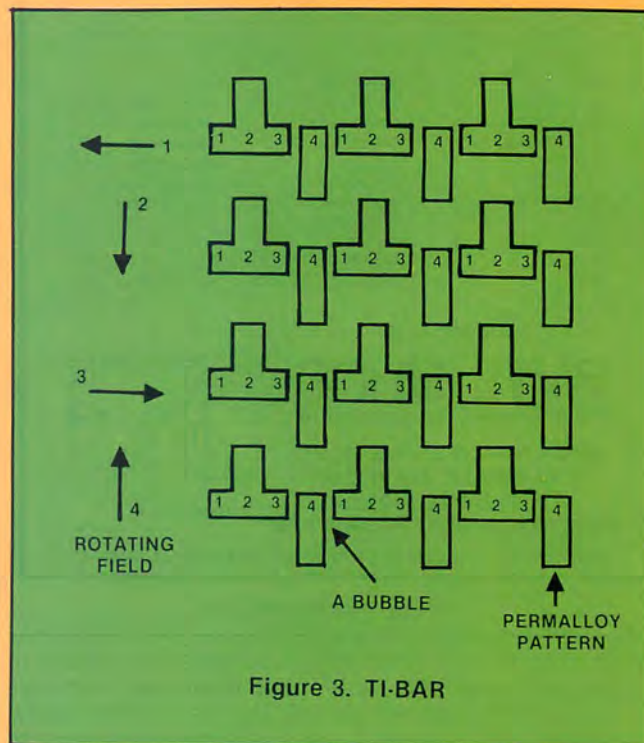
netic patterns placed on the surface of the chip. A number of configurations of these permalloy patterns have been developed including chevrons, contiguous disks, and Y-Bars; but the most successful approach so far is the TI-Bar configuration shown in Figure 3. As the field rotates, the bubble moves towards the weakest portion of the bias field. These magnetic "wells" are established at the left edge, center, and right edge of the T patterns as the rotating field assumes the vector positions shown as 1, 2, and 3. When the field vector is in position 4, the bubble moves to the position on the tip of the bar.

Detection is usually achieved through the use of a magneto-resistive element, or hall effect device, placed under a permalloy strip. As the magnetic bubble passes over the detector strip, the detection element changes resistance. In order to insure adequate signals the bubble is stretched many times its resting length; this stretching is the magnetic equivalent of preamplification. To minimize the effects of the rotating magnetic field, which would also produce an output in the detector element, the detector is configured as one leg of bridge where the other legs are composed of detector elements which are not subjected to the passage of bubbles. The differential signals resulting from this configuration are in the order of millivolts and are then amplified to TTL levels by an external read sense-amplifier.

As data is stored by the presence (or absence) of a bubble in the storage loop, some method must be provided to collapse, or annihilate, an unwanted bubble. The bubble can be annihilated by passing it under a current loop which is directed opposite of the generating loop. The resultant field opposes the stored field and destroys it. Another procedure is to just run the bubble into the permalloy guard rail which usually surrounds the chip perimeter. Annihilation is usually combined with replication to provide a user transparent non-destructive readout operation. In the readout process the bubble is generally stretched out and cut in two (replicated), and one of the clones is kept in the storage loop, while the other bubble is transferred to the detector and finally annihilated. While the process combines destruction and generation, to the user it appears transparent and is just seen as an NDRO device.

In a block organized device the bubbles will have to be moved from an interim transfer loop to one of several storage loops. A long parallel current loop is energized to perform this function for a common transfer device. The interim loop is generally referred to as the major-loop while the storage loops are called the minor-loops.

The configuration used by TI in the TBM 0101 92,304 bit memory is shown in Figure 4. This technique is called major-minor-common-transfer. Its advantages are fast access time ($2\sqrt{N}$ — where N is the number of bits), a reasonable return time ($(R-1)\sqrt{N}$), and few leads. Unfortunately, housekeeping is required to keep track of the bit storage positions, the location of the minor loop index. The use of individual, rather than common, transfer elements reduces the access time by a factor of two at the expense of a considerable increase in the number of



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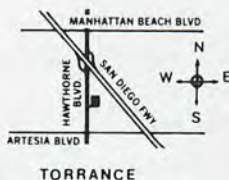
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leads. The simple single-loop configuration results in the fewest leads and easiest application as it is configured as a simple end-around shift register or digital delay line. This technique results in the largest access time (N) and becomes impractical for large N . This configuration is roughly equivalent to a tape-loop if a single-track forward-only machine is assumed.

A possible future organization could have only minor loops and decoded inputs/outputs with a guard rail detector. This scheme is quite similar to the CCD devices to be discussed later. Unfortunately, the magnetic decoders have not been proven, otherwise this technique will provide the fastest access time ($\log_2 \sqrt{N}$).

The TI TBM 0101 configuration as shown in Figure 4 utilizes a total of 157 minor loops, each of which has 641 bubble positions. In order to provide reasonable production yields in view of the tight geometries, it is allowable that a maximum of 13 of the 157 minor loops be defective. This provides a minimum data capacity of 144 good minor loops times 641 bits per loop for the specified value of 92,304 bits. At final chip test, the defective loops are identified, and a map of the usable/unusable loops is provided to allow masking of the defective loops. This masking must take place when bubbles (data) are inserted into the major loop to avoid transferring a data bubble to a defective minor loop. Because of the geometry of the device, minor loops may only be placed as close as every other bubble position. Therefore, data storage can only be done in alternate bit positions; the intervening spaces must be zeroes (no bubbles), or must be ignored during readout. Usually this masking is performed by storing a map of the defective loops in a PROM operating in conjunction with a controller chip. Each bit in a page of data would then be gated with the contents of the PROM, thus preventing bad data from reaching the data buffer.

Let's go through the operation of an MBM. In the write operation, data are introduced into the major loop via the generate current loop. The creation of a bubble during any 10 μ sec period will constitute a logic one. A logic zero will be defined as the absence of a bubble during a clock period. The major loop is essentially a unidirectional circular shift register, 157 bits long. A common parallel transfer element is provided to transfer the bits in the major loop to the top bit position of the minor loops. Thus a data block of 157 bits would be entered and shifted until the first data bit is aligned with the most remote minor loop. At that time the common-parallel transfer element would receive a current pulse which forces the magnetic domains to transfer to the top bit position of the minor loops. Remember the placement of the defective minor loops and geometry — adjacency effect must be allowed for. Once data is written into the MBM, new data may be written only by first removing the old data by means of a destructive read — that is a read without replication.

When performing a read operation, the data in the minor loops must first be rotated to place the block of data desired at the top bit position in the loop. At this time the transfer element is activated as it was during the write operation except with different timing within the 10 μ sec period. As a result, the bubbles will be removed from the top data position of each minor loop and placed in the major loop. The bubbles are then shifted to the replicator section of the major loop.

If a destructive read is desired, a field is set up prior to the arrival of the bubble by passing a current through the replicate current loop at the proper time to deflect the bubble into the detector track. If it is necessary to restore the data in the minor loops, the current amplitude and timing are adjusted to serially replicate the data in the major loop. As a result, duplicate data will be present in both the detector track and the downstream section of the major loop. The data in the detector track will pass across two identical detectors before it is annihilated in a guard rail.

The dual magneto resistive detector scheme allows for differential sensing at the output of the MBM for improved common-mode noise rejection characteristics. The net loaded signal amplitude is in the neighborhood of 3mV during the passage of the bubble in the detector region. This signal is shown along with a representation of the common mode noise in Figure 5.

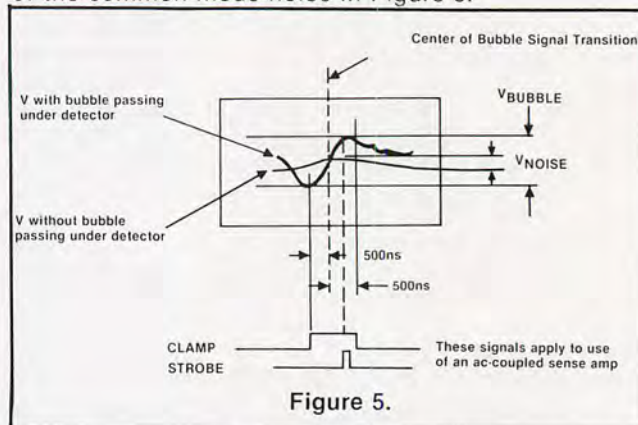


Figure 5.

The duplicate data remaining in the major loop is shifted until the first bit in the 157 bit block reaches the position above loop one. By this time the data in the minor loops have also made one full revolution; therefore, the data in the major loop is written into the minor loop by enabling the transfer element. Interleaving of consecutive data blocks in the major loop by doing two transfer out operations in succession is not permitted. However, it is permissible to have co-resident blocks in

the major loop if the first block of data is shifted into the upper half of the major loop before another block transfer is accomplished.

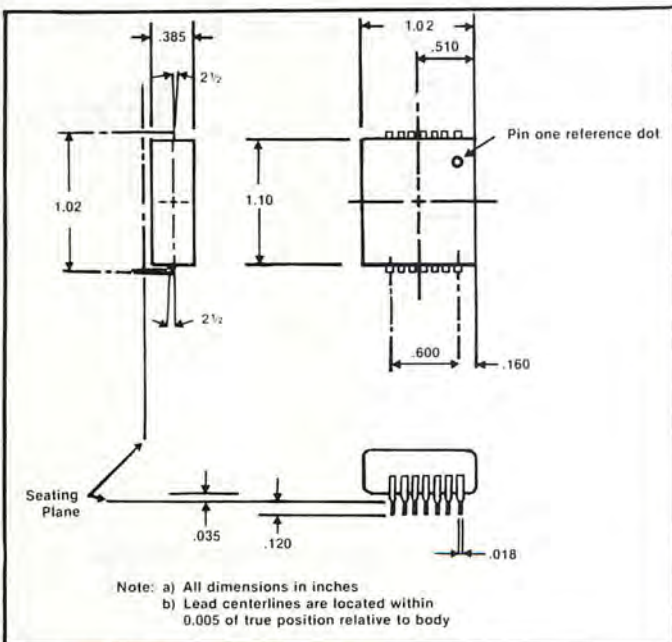
The position of the minor loops is tracked with the use of an external counter. The first position in the minor loops to be written into will be designated as address zero. The external counter is cleared to count zero and incremented each time the data is shifted one position, i.e., one complete 360 degree magnetic field rotation. Prior to a power down situation, the minor loops must be returned to a known position, usually address zero. Upon power up, the external counter is set to the predetermined count value to continue where it was when power was removed. Power supply integrity must be maintained during power down until the minor loops are correctly positioned.

Since the bubble travel is unidirectional, the worst case situation would happen when a transfer out operation from binary address 640 occurred at the same time as the beginning of a power shutdown. For a non-destructive read operation, the data must make one full revolution in the major loop before it can be transferred back into the minor loops. Then the minor loops must also be rotated one full revolution to address zero before power supply regulation is lost. The total elapsed time in this situation is 12.8 μ sec.

The following characteristics are those of the only commercially available magnetic bubble memory, the TI TBM 0101.

DEVICE CHARACTERISTICS

Major loop length	640 periods
Minor loop total	157
Minor loop usable	144
Minor loop length	641 periods
Useful capacity	92,304 bits
Maximum raw capacity	100,637 bits
Operating frequency	100 KHz
Average access time (first bit)	4.0 ms
Average cycle time (144 bit page)	9.6 ms
Data rate	50 Kb/sec
Hard error rate after N years residence time with operating duty cycle d	10^{-9} Nd errors/bit
Soft error rate	10^{-9}
Bias margin	8 Oersteds
Operating temperature	0 to 70°C
Non-volatile storage range	-40 to 85°C
Package size	1.0 x 1.1 x 0.4 inches
Weight	25 grams
Shielding capacity	40 Oersteds



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2102AL-2	250NS	1024 x 1	2.25
2111AL-4	450NS	256 x 4	2.45
2115AL-4	250NS	256 x 4	3.00
2114	250NS	1024 x 4	20.00
68A10	360NS	128 x 8	5.00
68B10	250NS	128 x 8	10.00
4100	250NS	4096 x 1	13.00

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8247	4 Digit Display Controller	14.00
8248	6 Digit Display Controller	14.00
8250	A Synch. Comm. Element	25.00
8251	Serial I/O	8.00
8253	Prog. Interval Timer	25.00
8254	16 Bit Prog. I/O	16.75
8255C	Prog. Peripheral Interface	8.00
8257	DMA Controller	25.00
8259	Prog. Interrupt Cont.	25.00
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8080A-1	3MHz CPU	21.00
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6802	Mot 1 MHz CPU with clock	32.00
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3850	F-8 CPU	25.00
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YA-3-1015A	UART (+5 volt only)	9.00
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74LS08	27	74LS93	1.00	74LS194	1.30
74LS10	27	74LS96	1.75	74LS195	1.40
74LS11	27	74LS125	1.50	74LS221	2.50
74LS13	60	74LS132	2.25	74LS365	1.25
74LS14	95	74LS136	1.35	74LS366	1.25
74LS15	28	74LS138	1.35	74LS367	.90
74LS16	28	74LS151	1.45	74LS368	.90
74LS17	28	74LS153	2.25	74LS393	4.00
74LS18	28	74LS154	2.10	8278	2.50
74LS19	30	74LS157	1.40	8278	3.50
74LS20	157	74LS158	1.56	8279	1.35
74LS21	110	74LS161	1.55	8279	1.35
74LS22	110	74LS163	2.10	8216	4.00
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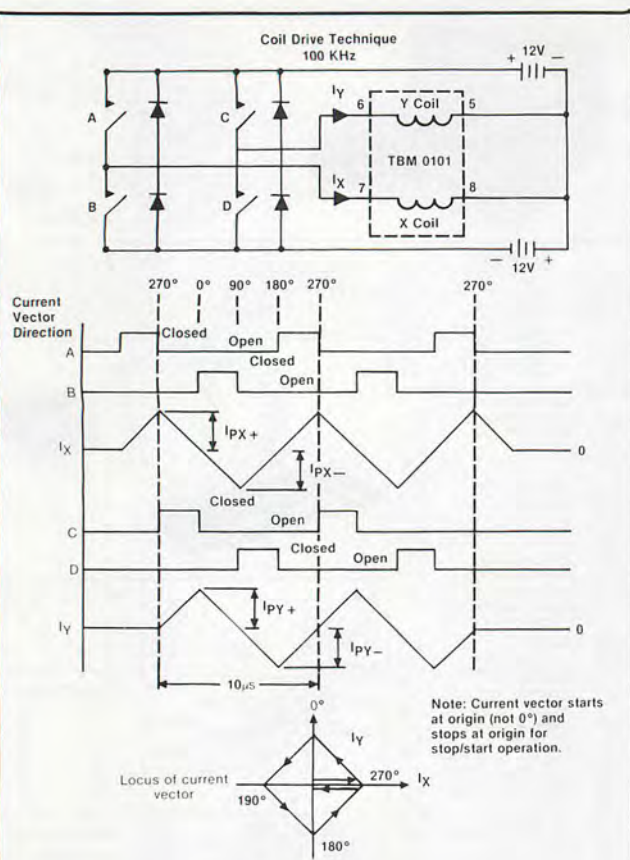


Figure 6.

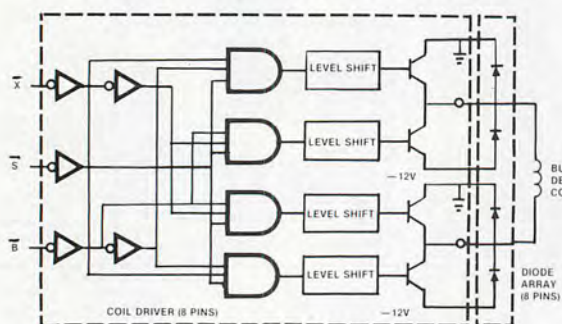


Figure 7. Coil Drive and Diode Array

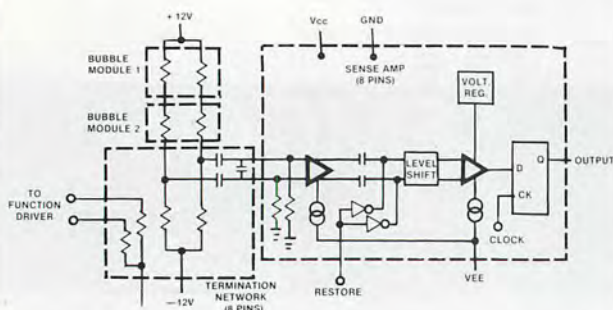


Figure 8. Sense Amplifier and Termination Network

An interesting view of the device is obtained by referring to the error rate specification. The TBM 0101 is shown to have a maximum soft error rate of 10^{-9} , which is generally less than most floppy disks. There is a hard error rate specification which is somewhat unusual. The hard bit error rate is given as $10^{-9}(N)(d)$ errors per bit; where N is the residence time in years, and d is the operating duty cycle. This product implies that operating the MBM as a frequently accessed RAM is not a very good idea, though a duty cycle of 1 for one year of use still results in a hard error rate of only 10^{-9} errors/bit — still small. If the device is supplied with an excess of good minor loops over the required 144, a reprogramming of the PROM containing the memory map would allow the substitution of a good loop for one containing a hard error.

It is not the intent of this article to get into a full fledged design of a bubble memory system; however, it is interesting to take a quick overview of the circuits/techniques necessary to make the MBM work.

Figure 6 illustrates the technique for driving the orthogonal coils to achieve the rotating magnetic vector including the correct initialization conditions. Figure 7 shows TI's method of achieving these coil drives.

The read sense amplifier used by TI is shown in Figure 8. A termination network is provided to form the other legs of the detector bridge. Also included are resistors to allow the chip drive currents (needed for generation, replication, transfer, etc.) to be compensated to match the temperature characteristics of the magnetic material. This is the same technique used in core memories.

The function drive circuit shown in Figure 9 converts the TTL compatible signals derived from the Function Timing Circuit into the constant current sources required by the bubble device. Various functions including Disable and temperature compensation are also performed on this chip.

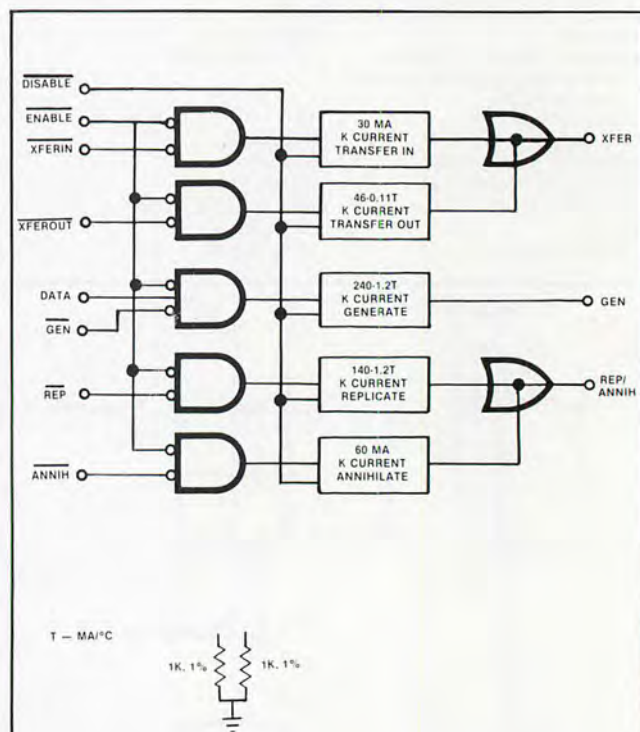


Figure 9. Function Driver Block Diagram

The Function Timer chip is required to appropriately time and sequence the coil drive currents and the chip control currents. A block diagram of the TI low-power Schottky device is shown in Figure 10.

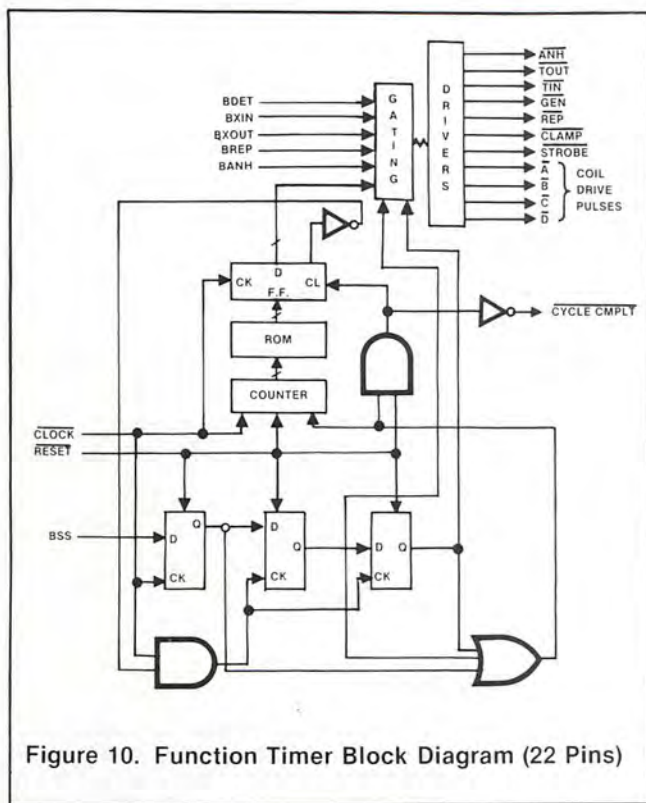


Figure 10. Function Timer Block Diagram (22 Pins)

Finally, as mentioned earlier, it is necessary to provide a function which controls the addressing, parallel-to-serial (and the converse) conversion required for data transfer, memory map masking, power up/down modes, and clock distribution. TI provides an MBM Controller device, the TMS 991JL, which is described in block diagram form in Figure 11. The overall diagram of a development MBM system is shown in Figure 12.

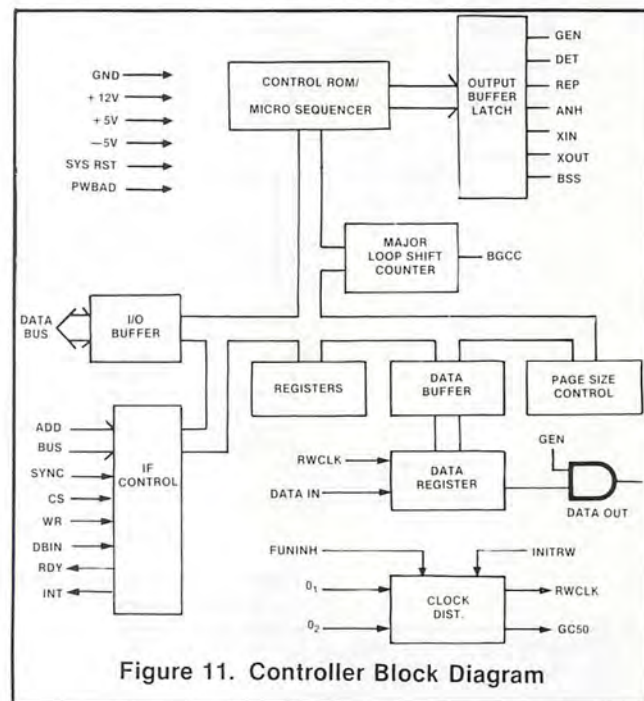


Figure 11. Controller Block Diagram

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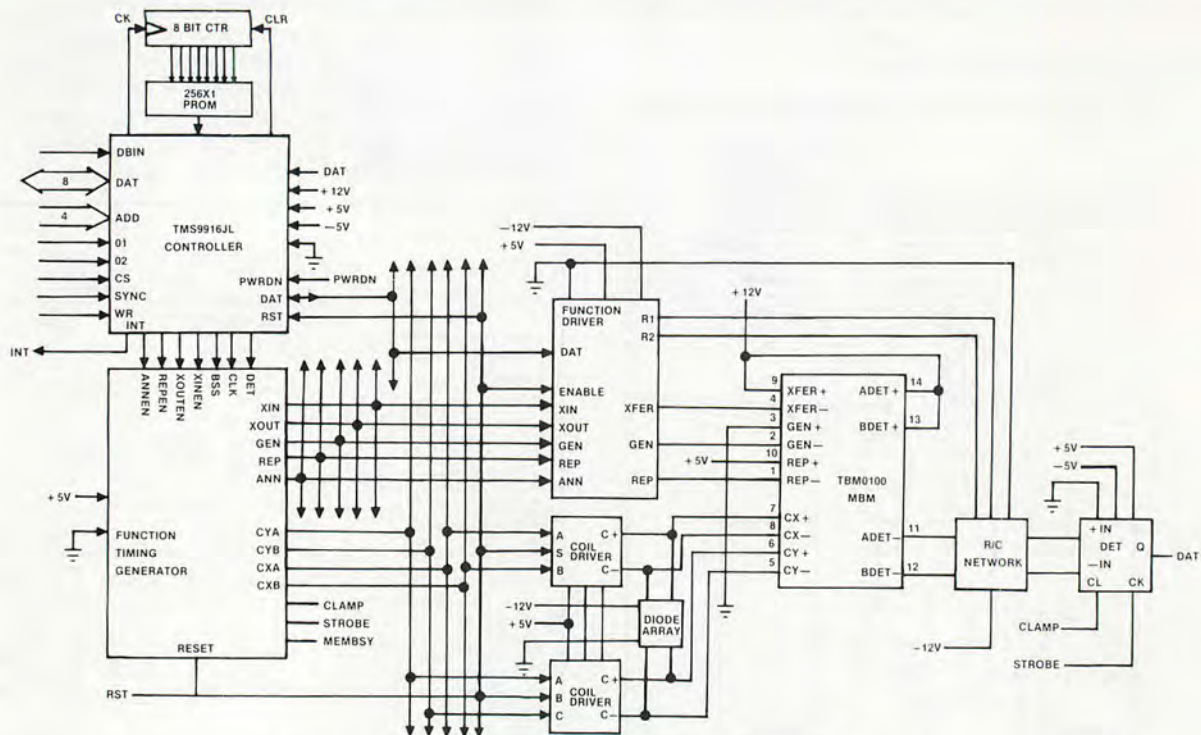


Figure 12. Magnetic Bubble Memory System with Interface Electronics.

We can now take a look at the other competing block organized semiconductor memory technique — the charge-transfer devices. For this article we will restrict our discussion to charge-coupled devices (CCDs) and not cover bucket-brigade devices (BBDs) or charge-injection devices (CIDs). The CID is not a memory technique but is used to implement imaging functions, and the BBD exhibits about a 20 db reduction in S/N (signal to noise) ratio when compared to a CCD. The device implementation of a CCD is simpler than that of a BBD and is therefore easier to fabricate.

The basic technique used by CCDs is to establish a series of "potential wells" in a silicon substrate. The potential, or depth, of each well is controlled by the voltage applied to the MOS capacitor above each well. If a phased series of voltages is applied to these capacitors, the relative height of each well can be varied to effect a directional transfer from well-to-well of the charges stored in each well. As we are talking about stored charge in an MOS device (ala dynamic MOS RAMs) the information storage is volatile and the memory must be continually refreshed. This is in direct contrast to the non-volatile nature of the previously discussed MBM. Usually two capacitor "wells" per bit are required to implement a data storage location. One of the "wells" acts as an interim storage area to provide the required directional characteristic.

The first commercially available CCD memories utilized a simple, approximately serial organization as typified by the Intel 2416 16K CCD memory shown in block diagram form in Figure 13. This device is organized as 64 recirculating CCD shift registers of 256 bits each, and provides an average latency time of less than 100 μ sec. This figure would exceed 8 ms if the device were configured as a 16K delay line shift register. The maximum serial data transfer rate is 2 Mbits/second. Any one of the 64 shift registers can be accessed by applying the appropriate 6-bit address. The address registers and decoders are also incorporated on the chip.

Access to the 64 recirculating registers is performed in a random access mode. A 6-bit address selects one of

the 64 registers for read, write, or read/modify/write operations. These random access operations are performed between shift operations and can be performed in any number or sequence as long as the basic shift frequency is maintained.

Because of substrate leakage currents the charge coupled storage mechanism is dynamic in nature. To satisfy the refresh requirements of the 2416, one shift operation must be performed every nine microseconds. This refresh requirement limits the number of random access cycles between successive shift operations to a maximum of 16.

Random access operations are performed in a manner which is very similar to any random access memory. All random access cycles are initiated with the rising edge and terminated with the falling edge of CE (Chip

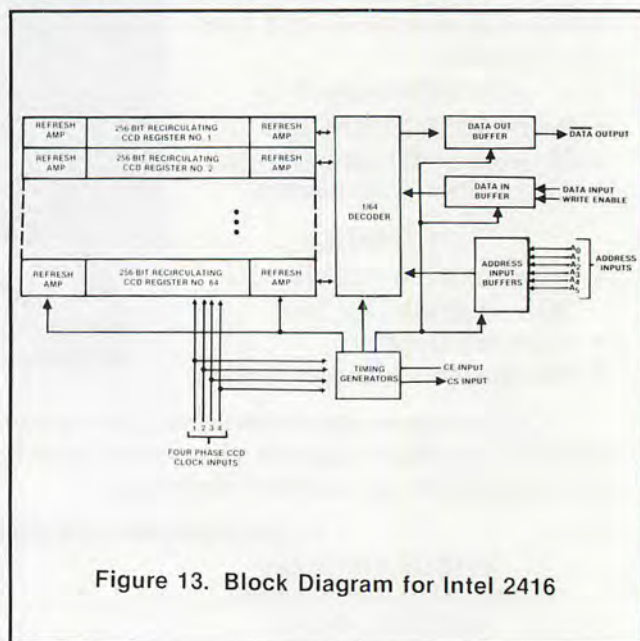


Figure 13. Block Diagram for Intel 2416

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Enable). Read operations are performed when WE (Write Enable) remains low throughout a CE cycle. Data is strobed into the memory whenever WE is strobed high during a CE cycle as illustrated in the appropriate timing diagrams. CS (Chip Select) controls only the input and output circuits and is only effective when CE is high.

The Intel 2416 generates and uses an internal reference voltage which requires some time to stabilize after the power supplies and four phase clocks have been turned on. No I/O functions should be performed until the four-phase CCD clocks have executed at least 4000 shift cycles with power supplies at operating voltages. After this start-up period, no special action is needed to keep the internal reference voltage stable.

A more sophisticated organization of a CCD memory is evinced by the Fairchild F464, a 65,536 bit dynamic device whose block diagram is shown in Figure 14.

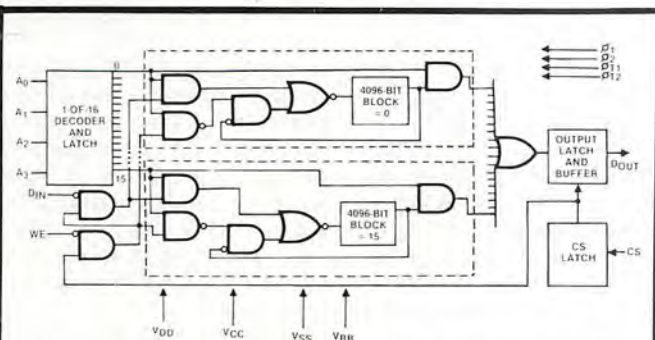


Figure 14. Block Diagram for F464

The F464 is a 65,536 x 1 bit dynamic serial memory organized internally as 16 dynamic shift registers (or blocks) of 4096 bits each in length. These 16 shift register blocks are randomly accessible through four internally decoded Address inputs (A_0 - A_3). When a given register is selected, its input and output are internally connected (as needed) to the D_{IN} and D_{OUT} pins, respectively, thus permitting simultaneous read and write operations.

Each of the 16 shift register blocks is implemented using a Serial-Parallel-Serial (SPS) register architecture. In this approach N data bits are sequentially shifted into a "serial" input register. When full, the entire N-bit word is shifted in parallel into N "parallel" registers of M bits in length, as illustrated in Figure 15. At the other end of this parallel register structure, bits are loaded in parallel into an N-bit serial output register. Bits in this register are then shifted out toward the sense amplifier at the output and are automatically recirculated back to the input serial register unless a WRITE operation is specified.

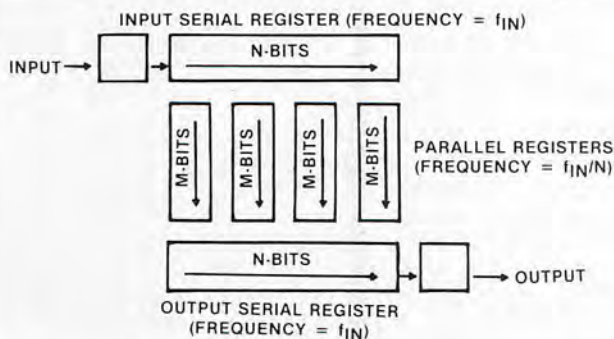
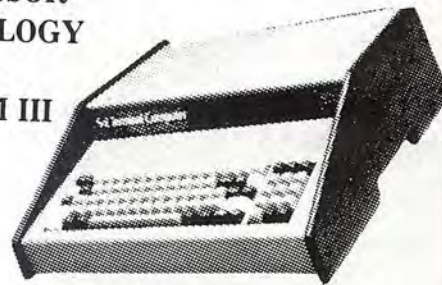


Figure 15. Simplified SPS Example with $N = 4$.

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In actuality, each 4096-bit block of the F464 is implemented using an "interlaced" SPS structure in which each bit of the input serial register services two parallel registers rather than just one. The same is true for the output serial register. In addition, "electrode-per-bit" design techniques are used to reduce the effective cell size by minimizing the number of electrodes used to store each bit of information. These techniques obviously enhance the memory density considerably. The dimensions of the F464's interlaced SPS structure are 32-bit input and output serial registers and 64 parallel registers, each 63 bits in length. (See Figure 16.) These dimensions were chosen in order to optimize the power/density/latency tradeoffs inherent in the CCD memory approach.

The primary advantages of this type of architecture include very high density, low power, and low clock capacitance. These features all result from the fact that in the SPS architecture the parallel registers which encompass most of the total storage capacity within each block are shifted at a considerably slower rate (f_{IN}/N) than the clock rate of the input or output serial registers (f_{IN}).

The overall result is a 65K bit memory with an average latency time of less than 400 μ sec and a power dissipation equivalent to the older 16K bit 2416. If the memory had been organized as a 65K serial register, the average latency time would have been on the order of 10's of

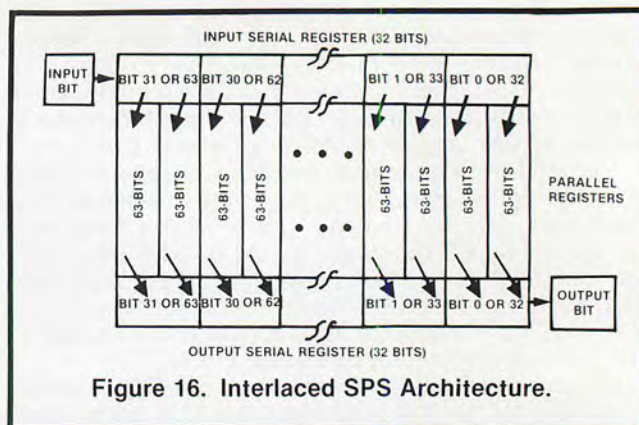


Figure 16. Interlaced SPS Architecture.

msec even at the 5 MHz clock rate, and the chip could not have been fabricated because of the high power dissipation.

Improvements in the fabrication of MOS devices, which have taken place since the design of the earlier 2416, allow the F464 to be halted for as long as 15 μ sec once each interval of 64 or more clock cycles, so long as the clock frequency is greater than 2 MHz. The F464 must be initialized after power-up, or whenever the clock has been halted for a period greater than 15 μ sec. Because of the much larger size of the F464, it must be clocked through a minimum of 20,000 clock cycles before attempting a valid memory cycle.

This completes our discussion of memories; next month we will begin to look at the CPU (Central Processing Unit) both from an architectural and implementation viewpoint. □

INTERFACE AGE HAS CLOSE ENCOUNTER



This last April a story was presented on a robot that supposedly met everyone's expectations. Unfortunately, it was nothing more than a sales gimmick. But exciting it was and is. This August, in the annual gaming issue another robot, called Orion, will be presented in the Editor's Notebook. The manufacturers of this robot have made no extravagant claims, but offer the robot as an exciting precursor of things to come.

Orion is not the only subject to be covered in the Notebook next month. Exciting coverage of NCC and new products is also planned.

The August issue will also have some of the most exciting games to be published to date: Roulette, Ping Pong and graphic techniques.

We also have some other exciting features coming in the following months. One of which is the Inventor's Sketchbook. This column will feature ideas from Roger Garrett and other authors who have an unusual idea or theory that fits into the realm of microcomputing. For authors interested in writing for this column the following guidelines must be followed:

- The idea must be original with you.
- The manuscript must not be over six double-spaced typewritten pages.*
- Send all manuscripts to:

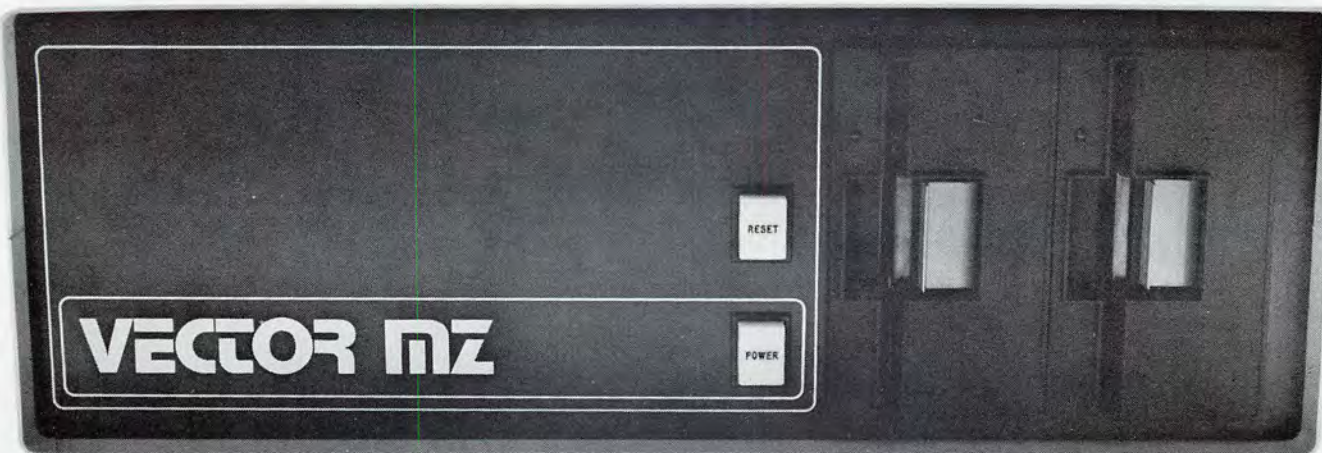
INVENTOR'S SKETCHBOOK, INTERFACE AGE Magazine, P.O. Box 1234, Cerritos, CA 90701.

Articles submitted for this column will be paid at the prevailing rates, based on interest level presentation and clarity of the material. Please submit only one manuscript per three month period.

If you are ready for your own encounter, prepare yourself for August and the months to follow. Better yet, have all your neighbors join in the fun. □

*See March 1978, page 32a for Style Guide.

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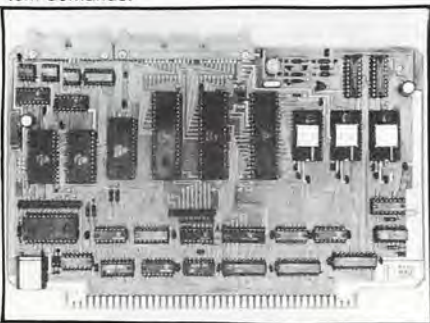
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The 9600 pricing ranges from \$495 in single quantities to \$297 at the 100-piece level. Delivery is from stock. For additional information contact Creative Micro Systems, 6773 Westminster Ave., Westminster, CA 92683, (714) 892-2859.

CIRCLE INQUIRY NO. 117

Microprocessor N/C Wirewrapping System Offers High Reliability/ Low Maintenance

A microprocessor controlled, semi-automatic wirewrapping system designed for production line operation is available from Computer Numerical Control Corporation.



The CNC 1000S uses a microprocessor N/C to minimize electronic hardware, improve reliability, and cut power consumption to a typical 350 Watts. Binary N/C tape formatting reduces paper tape length by 80% compared to ASCII or EIA formatting.

The CNC1000S with microprocessor N/C is priced at \$11,900. Other models from \$8950 are also available. For more information contact Computer Numerical Control Corp., 460 New Boston Park, Woburn, MA 01801, (617) 933-0091, George Kakridas, Marketing.

CIRCLE INQUIRY NO. 124

F-8 Products

Comptronics has announced the introduction of two new F-8 products for the serious hobbyist and design engineer.

The first product is an F-8 CPU board compatible with the S-100 bus. Complete with 3850 CPU and 3853 SMI, the unit provides sockets

for 2K of EPROM monitor, two PIO sockets, and connectors for six I/O ports. The board has 64 bytes of scratch pad RAM, and a fully buffered data bus. The Model F-8S100 sells for \$239 as a kit, or \$275 assembled.

The second product is an F-8 microcomputer with keyboard and 6-digit display. The unit provides audio interface and speaker compatible with the on-board KD-BUG (3856) music routine, 2K of RAM expandable through an S-100 connector, and 1K of EPROM with 4 additional 2708 sockets. Model KD80 sells for \$375 as a kit, and \$425 assembled.

For more information contact Comptronics, 19824 Ventura Blvd., Woodland Hills, CA 91364, (213) 340-8843, Don Swanke.

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The SOL*STAR 8080 Data Processing System is a turn-key package designed for small business applications, including word processing, bookkeeping, engineering, legal billing, apartment management, document preparation, and data base management.



The \$7,000 model pictured above, which includes 32K of memory and a Multiterm/Diablo printer, is designed to attract the professional and small business market. Based on the popular SOL-20 Computer and North Star disk drive combination, SOL*STAR adds special software, dual-sided disk recording with Pertec drive units, and custom cabinetry.

For complete information send a stamped, self-addressed envelope to the Orange County Computer Center, 1913 Harbor Blvd., Costa Mesa, CA 92627. Dealer inquiries are invited.

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Low-Cost Timesharing Minicomputer

The first in a series of small computer systems designed to handle high-throughput timesharing applications with the architecture of mainframe processors — at lower prices than comparable large-scale minicomputers — is available from Digital Scientific Corporation.



Designated the META 4+ /5000 Series, these 16-bit computers will range in size from powerful low-end processors aimed at the upper OEM market to high-end systems offering per-

formance characteristics approaching those of mid-range IBM System 370 CPUs.

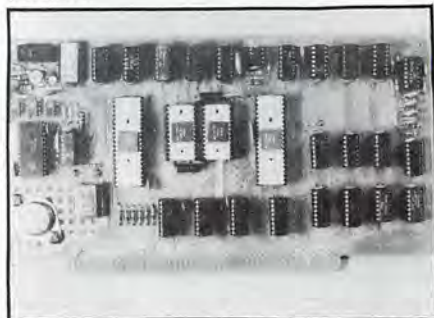
The first of this new series, the Model 5020, provides multiprogramming control for up to 32 job streams, including two concurrent card reader/punch jobs and up to 30 terminals, in interactive, batch or remote-batch timesharing applications.

For more information contact Digital Scientific Corp., 11425 Sorrento Valley Rd., San Diego, CA 92121, (714) 453-6050.

CIRCLE INQUIRY NO. 125

Auto Computer

The first, self-contained, driver-operated automotive computer, capable of instantly displaying dash data as MILES TO GO, VEHICLE LOCATION, ESTIMATED TIME OF ARRIVAL, MILES PER GALLON, COST PER MILE, and 19 other important functions, is now being marketed by OBC Products Division of Prince Corporation.



The Prince On-Board Computer, which is extremely compact (10½"x2½"x1¼") and weighs less than one pound, is easily installed in cars, trucks or vans by connecting a speed transducer and fuel flow transducer, both supplied with the computer.

Prince Corporation plans to have their On-Board Computer in national distribution by early 1979. Company officials expect the retail price to be around \$400. For more information contact OBC Products Div., Prince Corp., Konrad Marcus, (800) 253-5495 (U.S.A.), (800) 632-7057 (Michigan).

CIRCLE INQUIRY NO. 114

System 25

Wang Laboratories has a series of disk-based word processing systems that will give users powerful processing capabilities as well as the ability to configure an office system to fit their present needs and then to expand with them.



System 25 is available in three models, each with successively larger storage capacities and configuration capabilities. It is unique in its ease of system back-up.

Starting at a base price of \$12,100 for the master unit and disk drive System 25 Model I has 1.25 megabytes of storage capacity (approximately 500 pages of text) and the ability to interface with up to six peripherals, such as

work stations and printers, of the users' choice, allowing them to configure their own office systems.

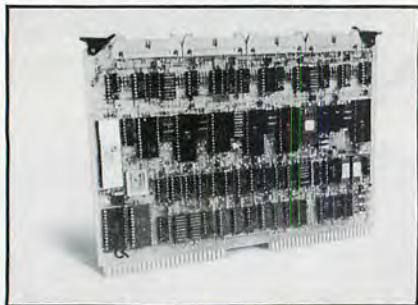
Models II and III can accommodate up to 14 peripheral devices. Maximum storage is 2.5 megabytes on the Model II and 5 megabytes on the Model III. The use of rapid access disks and diskettes gives the System 25 its unparalleled performance capabilities.

For more information contact Wang Laboratories, Inc., One Industrial Ave., Lowell, MA 01851, (617) 851-4111, ext. 2385, Sheryl Garelick, Frederick Wang.

CIRCLE INQUIRY NO. 115

Single Board Computer (MM1-MS-C)

A single board computer, believed to be the first to provide multiple serial communications ports, is available from Control Logic, Inc. The MM1-MS-C has four serial I/O ports which can communicate asynchronously at selectable baud rates of 110 to 9600 baud or synchronously at data rates in excess of 50K baud.



Processing capability is provided by a Zilog Z-80 CPU with 1K bytes of 2708 EPROM or 2K bytes of 2716 EPROM and 1280 bytes of RAM. A priority interrupt controller provides interrupt capability upon receipt of data from all four ports as well as three external interrupt states.

Price of the MM1-MS-C is \$950 in single quantity. Delivery is 30 days ARO. For more information contact Control Logic, Inc., 9 Tech Cir., Natick, MA 01760, (617) 655-1170, Hiram French.

CIRCLE INQUIRY NO. 116

Cado Adds Multi-Terminal, Multi-Tasking Computer for Bell Terminals

The new Cado System 40/IV is plug compatible with AT&T's Dataspeed 40 CRTs and printers. This system permits Bell System customers to tie together multiple Dataspeed 40 terminals with the new Cado CPU.



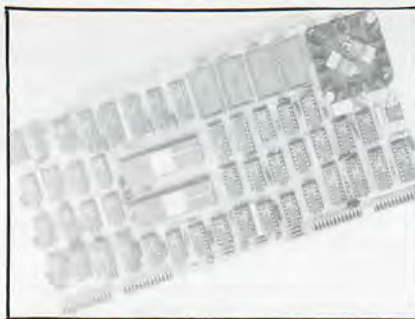
The Cado add-on-sub-system plugs directly into a Dataspeed 40 via the standard EIA connector.

For more information contact Cado Systems, 2730 Monterey St., Torrance, CA 90503, (213) 320-9660.

CIRCLE INQUIRY NO. 122

4 MHz Single Card Computer

Cromemco's Single Card Computer is a complete computer which brings the power of the Z-80 and the flexibility of the S-100 bus to the dedicated computer environment.



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The Single Card Computer is available in kit form for \$395 and assembled and tested for \$450. For more information please contact Cromemco, Inc., 280 Bernardo Ave., Mountain View, CA 94040, (415) 964-7400.

CIRCLE INQUIRY NO. 123

COMPU-TEXT® Adds New Electronic Typing Station

Compu-text has added a faster electronic typing station to its modular shared-logic word processing system.

The new electronic typing station contains an automatic right margin justification feature and is 22 percent faster than the earlier model it replaces.



The new typing station uses a Qume daisy wheel mechanism and is now the primary input/output terminal for the Compu-text System. It provides high-quality output for finished typing and final drafts at the rate of 55 characters per second, or 10 times faster than an executive secretary typing at the rate of 64 words per minute.

For more information contact Tom Hoy, Director of Sales, at (617) 848-1800, or write to LCS Corp., 287 Wood Rd., Braintree, MA 02184.

CIRCLE INQUIRY NO. 120

VERSATILE 3B or VERSATILE 4

Computer Data Systems has available their disk-based computer systems, the Versatile 3B and their expanded version, the Versatile 4.

This single unit computer combines a 9" video screen with 24x80 display, built-in mini-floppy disk drive with 143K bytes of storage, upper/lower case alphanumeric keyboard, separate numeric keypad and all electronics within a single durable plastic enclosure.



The computer mainframe incorporates the 8085 CPU, 24K static RAM and a serial I/O port with RS-232 connector. The Versatile 4 expands on this system by providing 32K static RAM and 315K bytes of storage.

For complete information, contact Computer Data Systems, 5460 Fairmont Dr., Wilmington, DE 19808, (302) 738-0933.

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The program required over 10,000 programming hours, and is entirely written in Z-80 assembly language to improve response time. The company OEM and assembles its own equipment for improved reliability and maintains its own service group.

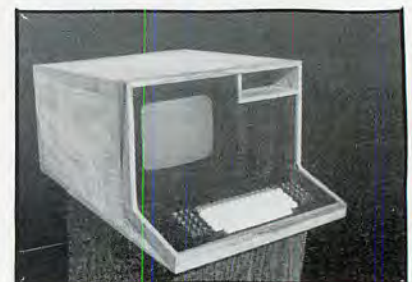
For release later this year, the company plans a similar system for Doctors' offices. For further information contact Kerr & Reynolds, 4372 Woodman Ave., Sherman Oaks, CA 91423, (213) 995-8570.

CIRCLE INQUIRY NO. 112

85/9 = 8085 + PASCAL

The new 85/P programmers workbench from Northwest Microcomputer Systems, Inc., combines the throughput of the 2MHz Intel 8085A and the power of PASCAL.

Designed for the serious applications programmer, the 85/P is a complete and fully integrated system that utilizes high reliability components and modular design to insure minimum down time.



The standard system features 8085A CPU, a PASCAL compiler/interpreter, CP/M™ supporting BASIC, COBOL (July) and FORTRAN, Direct Memory Access, two Shugart floppy disk drives with one megabyte of on-line storage, 54K of 450ns user available static RAM, a Hall Effect Keyboard with 103 keys, two serial ports (RS232C), two parallel ports (16 bits), 24 x 80 character 12" video display, all enclosed in a single cabinet.

Pricing for the complete system is \$7495. Delivery is quoted at 30 to 60 days. For more information contact Northwest Microcomputer Systems, Inc., 121 E. 11th, Eugene, OR 97401, (503) 485-0626.

CIRCLE INQUIRY NO. 113

Proprietary Processor

A high-speed, high-performance arithmetic processor that performs a full range of mathematical functions is available from Advanced Micro Devices.

The Am9511 was developed by AMD to enhance, through hardware implementation the arithmetic capability of a wide range of processor-oriented systems, especially 8-bit MOS microprocessors. This Advanced Micro

Devices' circuit will perform fixed-point single- and double-precision (16/32-bit) and 32-bit floating-point operation in a binary format. Functions available include add, subtract, multiply, divide, square root, sine, cosine, tangent, inverse sine, cosine and tangent, common and natural logarithms and exponentials and powers.

Prices for the Am9511 start at \$175.00 in 100-piece lots. For more information contact Advanced Micro Devices, Inc., 901 Thompson Pl., Sunnyvale, CA 94086, (408) 732-2400, E. Sopkin.

CIRCLE INQUIRY NO. 126

S6800 Microprocessors Operate At Higher Temperatures

American Microsystems, Inc., has introduced S6800 microprocessors capable of operating at temperatures between -40°C and $+85^{\circ}\text{C}$ industrial range and -55°C to $+125^{\circ}\text{C}$ for the military. (The standard temperature range is 0 to 70°C .)

The new industrial and military temperature S6800 ranges are designed to fulfill the requirements for manufacturers of automobiles, remote microprocessor-controlled equipment, avionics and controllers used in extreme temperature environments.

These S6800 microprocessors are available in ceramic packages and are available through distributors or directly from American Microsystems, Inc. Prices are \$35.30 for industrial and \$68.40 for the military range in quantities of 100. For more information contact American Microsystems, Inc., 3800 Homestead Rd., Santa Clara, CA 95051, (408) 246-0330, Tom Edel, Manager of Marketing Services.

CIRCLE INQUIRY NO. 127

Low-Cost Microprocessor-Based Business Computing System

ABACUS 1 is a low-cost, microprocessor-based business computing system that combines accounting functions with word processing. The new system is a complete hardware and software package designed to handle basic accounting for small businesses.

Abacus 1 includes a Z-80 microprocessor, dual North Star disk system, video display,



keyboard and printer, plus software.

Prices for the Abacus 1 start at \$5995. Delivery is 30-60 days ARO. Dealer and OEM prices available upon request. For more information contact Computer Products of America, Div. of The Computer Mart, 633 W. Katella Ave., Orange, CA 92667, (714) 633-1222.

CIRCLE INQUIRY NO. 128

Microcomputer-Based Controller with BASIC

The BASIC Controller™ is a single-board programmable microcomputer system designed specifically for control applications.

The BASIC Controller can manage electrical systems in a building, automate the control of laboratory test equipment, operate a model railroad train, and apply itself to hundreds of other applications.



The unique feature of the BASIC Controller is that it allows the user to operate the computer and the external devices it controls with a BASIC language called ZIBL™ which was

written specifically for control applications.

On-board hardware includes a Z-80 MPU, 32 flags, 32 sense, 8 relays, 8 lites, 2 serial I/O, 1 parallel I/O, a cassette I/O, 64x16 video I/O, keyboard port, two 2716 sockets with programming capability, up to 16K on-board RAM (4K included).

The BASIC Controller retails assembled, tested and warranted one year for \$750. For more information contact Dynabyte, Inc., 4020 Fabian, Palo Alto, CA 94303, (415) 494-7817, Rick Mehrlich.

CIRCLE INQUIRY NO. 110

Basic MICRO-68

The Micro-68 Computer System is a complete ready-to-use microprocessor offering an economical solution for both scientific applications and industrial usage.

Built around the Motorola/AMI/Hitachi 6800 microprocessor, the Micro-68 comes with its own integral power supply, 16-button keyboard, a 6-digit LED display, and 128 words of RAM. The 512 MON-1 Bus PROM contains all the service necessary to load programs easily, inspect and edit them as necessary, insert break points for debugging, and execute.



Memory expansion to 64K and full 16-bit I/O can be obtained by convenient edge connectors which are provided for.

The Micro-68 computer system is priced at \$495 and comes completely assembled. Delivery is from stock. For more information contact Electronic Product Associates, Inc., 1157 Vega St., San Diego, CA 92110, (714) 276-8911.

CIRCLE INQUIRY NO. 111

Peripherals

Versatile Impact Printer

The Integral IP-125 Impact Printer features an RS232C serial interface, parallel TTL level interface and full upper and lower case ASCII character set (96 characters) as standard equipment.



Capable of printing multiple copies on an ordinary $8\frac{1}{2}$ " roll, fanfold or sheet paper, the microprocessor controlled IP-125 incorporates a 256 character multi-line buffer to achieve an instantaneous print rate up to 100 characters per second with a sustained throughput of 50 cps at 80 columns per line.

The Integral IP-125 Impact Printer sells for

\$799. OEM and quantity discounts are offered. For literature and/or more information contact Integral Data Systems, Inc., N. Lamade, Director of Sales, 5 Bridge St., Watertown, MA 02172, (617) 926-1011.

CIRCLE INQUIRY NO. 147

Centronics Introduces \$695 Microprinter with Serial Interface

The Microprinter S1 with serial interface is a nonimpact printer which not only offers a single unit price of \$695, but which also allows the user to select baud rates, parity, and the number of stop bits.



The unit is aimed at the home, hobby, and microprocessor markets and is ideally suited for use in diagnostic systems, CRT hard copy applications, industrial instrumentation, demand message printing, and as a remotely placed message printer.

For more information contact Centronics Data Computer Corp., Hudson, NH 03051, (603) 883-0111.

CIRCLE INQUIRY NO. 145

Light Pen Measurement System for Measuring Internal Organs

A computerized means of measuring the sizes, areas, lengths, and volumes of internal organs from cross-sectional video display images has been developed by Varian Associates.

The device, known as a light pen measurement system, can be used as an accessory to the recently-introduced Varian V-3000 Phased Array Ultrasonograph.

One important application of the light pen is in cardiology. By using the pen on images taken at end systole and end diastole, stroke volume and ejection fraction can be computed.

Measurement functions are selected by pointing the light pen at one of a series of labeled boxes displayed on the CRT. A calibration procedure is first performed which adjusts

the horizontal and vertical scales. After calibration, the operator can draw lines either free-hand or using a software vector generator. The lengths of lines or arc lengths and areas of enclosed figures are automatically computed on command. Results of the calculations are displayed on the video screen.

The light pen incorporates an 8-bit micro-processor which performs logical and arithmetic operations and outputs data to a synchronized digital display memory which is overlaid on the video image.

The light pen system is priced in the range between \$12,500 and \$15,000. For more information contact Varian Associates, 611 Hansen Way, Palo Alto, CA 94303, (415) 493-4000.

CIRCLE INQUIRY NO. 144

300 Line Per Minute Printer Family

The "INNOVATOR" family includes three models offering both parallel and serial interfaces at prices obtainable only by dot matrix

printers in the past. The family features the Teletype Corporation's 300 line per minute tractor feed model 40 housed in an "intelligent" sound reducing floor mount free standing acoustic cabinet.



Offerings include the 80 column (154), the 132 column (202) and the 72 column (250) forms

access printer. All models operate at 300 LPM and utilize tractor feed mechanisms.

The quantity one price is \$3,600 for the 154, \$4,300 for the 202, and \$3,950 for the 250. Delivery is 30 to 60 days ARO. For further information contact George Harrison, Innovative Electronics, Inc., 15200 N.W. 60th Ave., Miami Lakes, FL 33014, (305) 558-1591.

CIRCLE INQUIRY NO. 148

Type 511 Image Digitizer

The Periphicon Type 511 Optical Image Digitizer adds to the computer the ability to perceive events and artifacts in the real world. A 32 by 32 element picture is created in a form which is easily accepted by almost any computer system.



A fast (f1.9/13mm) lens that will focus from 0.2 meters to infinity allows the Type 511 to be applied to the solution of problems in such fields as robotics and process control.

The Type 511 is suited for work in the factory as well as in the lab. All aluminum case is machined from high quality bar stock, and has a minimum wall thickness of 2mm. Included is an integral 1/4-20 thread for mounting.

Price is \$200, postage and insurance paid. Delivery is 3 weeks ARO. For more information contact Periphicon, P.O. Box 324, Beaverton, OR 97005.

CIRCLE INQUIRY NO. 150

600-LPM Band Printer

Dataproducts Corporation has introduced the Model B-600 band printer. The printer uses a steel band font carrier, the patented Mark V hammer system, custom integrated-circuit hammer drivers, and microprogrammed control to produce 600 line-per-minute throughput at a significant reduction in price.



The keys to the new printer's performance, reliability, and maintenance lie in Dataproducts' unique hammer system, in the printer's simple mechanical design, and in state-of-the-art electronics and diagnostic systems.

For further information contact Dataproducts Corp., 6219 DeSoto Ave., Woodland Hills, CA 91364, (213) 887-8451, Al Erickson.

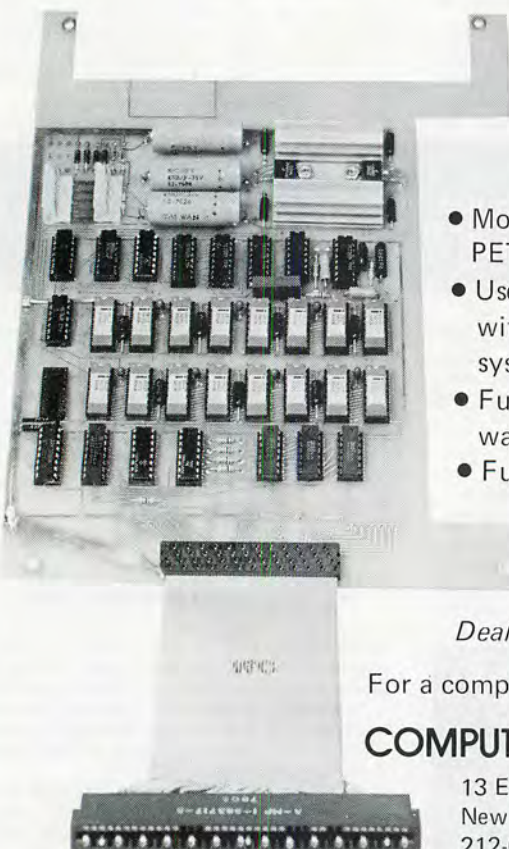
CIRCLE INQUIRY NO. 134

Gould Electrostatic Plotter Products

The 5400 Electrostatic Plotter handles 36-inch wide paper and plots with a resolution of 0.010 inch (100 dots/inch) horizontally and vertically. It is ideal for generating "E" and larger size drawings for computer-aided design, hardcopy of PERT, CPM or Gantt charts for project management, mapping, and other computer graphics hardcopy applica-

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APPLE II SERIAL I/O INTERFACE *

Part no. 2

• Baud rates up to 30,000 • Plugs into Apple Peripheral connector • Low-current drain • RS-232 Input and Output. SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer. • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some selectrics. Board only — \$15.00; with parts — \$42.00; assembled and tested — \$62.00.



T.V. TYPEWRITER

Part no. 106

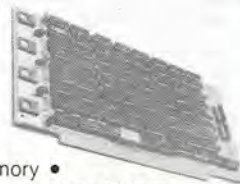
• Stand alone TVT • 32 char/line, 16 lines, modifications for 64 char/line included • Parallel ASCII (TTL) input • Video output • 1K on board memory • Output for computer controlled cursor • Auto scroll • Non-destructive cursor • Cursor inputs: up, down, left, right, home, EOL, EOS • Scroll up, down • Requires +5 volts at 1.5 amps, and -12 volts at 30 mA • All 7400, TTL chips • Char. gen. 2513 • Upper case only • Board only \$39.00; with parts \$145.00



8K STATIC RAM

Part no. 300

• 8K Altair bus memory • Uses 2102 Static memory chips • Memory protect • Gold contacts • Wait states • On board regulator • S-100 bus compatible • Vector input option • TRI state buffered • Board only \$22.50; with parts \$160.00



MODEM *

Part no. 109

• Type 103 • Full or half duplex • Works up to 300 baud • Originate or Answer • No coils, only low cost components • TTL input and output serial • Connect 8 ohm speaker and crystal mic. directly to board • Uses XR FSK demodulator • Requires +5 volts • Board \$7.60; with parts \$27.50



DC POWER SUPPLY *

Part no. 6085

• Board supplies a regulated +5 volts at 3 amps., +12, -12, and -5 volts at 1 amp. • Power required is 8 volts AC at 3 amps., and 24 volts AC C.T. at 1.5 amps. • Board only \$12.50; with parts excluding transformers \$42.50



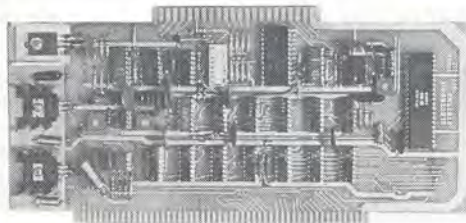
TAPE INTERFACE *

Part no. 111

• Play and record Kansas City Standard tapes • Converts a low cost tape recorder to a digital recorder • Works up to 1200 baud • Digital in and out are TTL-serial • Output of board connects to mic. in of recorder • Earphone of recorder connects to input on board • No coils • Requires +5 volts, low power drain • Board \$7.60; with parts \$27.50



TIDMA *



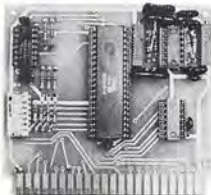
Part no. 112

• Tape Interface Direct Memory Access • Record and play programs without bootstrap loader (no prom) has FSK encoder/decoder for direct connections to low cost recorder at 1200 baud rate, and direct connections for inputs and outputs to a digital recorder at any baud rate. • S-100 bus compatible • Board only \$35.00; with parts \$110.00

UART & BAUD RATE GENERATOR *

Part no. 101

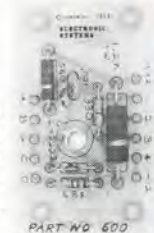
• Converts serial to parallel and parallel to serial • Low cost on board baud rate generator • Baud rates: 110, 150, 300, 600, 1200, and 2400 • Low power drain +5 volts and -12 volts required • TTL compatible • All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity. • All connections go to a 44 pin gold plated edge connector • Board only \$12.00; with parts \$35.00 with connector add \$4.00



RS 232/TTY INTERFACE *

Part no. 600

• Converts RS-232 to 20mA current loop, and 20mA current loop to RS-232 • Two separate circuits • Requires +12 and -12 volts • Board only \$4.50, with parts \$7.00



RS 232/TTL INTERFACE *

Part no. 232

• Converts TTL to RS-232, and converts RS-232 to TTL • Two separate circuits • Requires -12 and +12 volts • All connections go to a 10 pin gold plated edge connector • Board only \$4.50; with parts \$7.00 with connector add \$3.00



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Z-80 Microprocessor 5 @ \$20.00 ea.	8224-4 Clk. Gen. & Dvr. 25 @ \$8.75 ea.	410D (200ns) Static Ram 100 @ \$9.50 ea.	TMS 4044 (250ns) 16 @ \$8.95 ea.	4200 A (200ns) Static Rams 25 @ \$10.00 ea.	74 LS367 Hex Buffer 100 @ .70¢ ea.	74 LS368 Hex Inverter 100 @ .70¢ ea.	2513 (5v) Character Gen. 5 @ \$9.00 ea.

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MICROPROCESSOR'S	MISC. OTHER COMPONENTS
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8080 28.00	N8T95 1.35
CDP1802CD 19.95	N8T96 1.35
2650 24.95	N8T97 1.35
AM2901 22.95	N8T98 1.35
6502 11.95	81LS95 2.00
6800 18.95	81LS97 2.00
6802 25.00	1485 1.75
8080-1 19.95	1489 1.75
8035 22.00	D3205 4.00
8080 A 11.95	D3207 A 4.55
8085 27.00	D3208 A 14.20
TMS9900TL 75.00	B3222 10.00
	B3222 9.75
	B3242 10.15
	D3245 5.60
	C3404 6.75
	P3408 A 12.00
	P4201 A 7.50
	MM5320 7.50
	MM5369 1.90
	TMS501 24.95
	DM8130 2.90
	DM8131 2.75
	DM8833 2.50
	DM8835 2.50
	DM8837 1.75
	MKS0240 20.00
	MKS0250 15.00

8080A SUPPORT DEVICES

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8216 3.75	8224 3.50
8224-4 9.95	8226 7.95
8228 7.95	8238 7.50
8251 9.95	8253 21.95
8255 21.95	8257 21.95
8259 21.95	8275 75.00
8279 20.00	

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1771B 55.95	1771B-01 57.95
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PROM'S

1702 A 4.00	2704 15.00
2708 12.00	2716 30.00
2716 Int'l 38.00	2759 26.60
D3601 4.50	D3604 13.00
5203AQ 5.00	5204AQ 7.50
6834 17.50	6834-1 14.95
82S23B 4.00	82S129B 4.25
8223B 3.50	

6800 SUPPORT

6810P 4.95	68B10P 6.00
6820P 7.50	6821P 7.50
6822P 11.25	6834P 16.95
6850P 9.75	6852P 11.75
6860P 10.00	6862P 14.50
6871P 28.00	6875P 8.75
6880P 2.50	

Z80 SUPPORT DEVICES

3881 12.95	3882 12.95
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CHARACTER GENERATORS

2513 6.75	2513 5v upper 9.75
2513 5v lower 10.95	2516 10.95
MCM6571 10.95	MCM6571 A 10.95
MCM6574 13.25	MCM6575 13.25

WAVEFORM GENERATOR

8038 3.50	MC4024 2.25
566 1.50	

DYNAMIC RAMS

415D4116 32.00	1103 1.00
2104 4.00	2107B 4.25
2107B 4.25	2107B-4 11.95
TMS4050 4.00	TMS4060 4.50
TMS4070-2 32.00	4096 4.00
4116 A16D 32.00	MM5270 4.50
MM5270 4.50	MCM6605 5.00

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UART'S

AVS-1013A 5.25	AVS-1014A 8.25
TR1602B 5.25	TMS6011 5.95
IM6402 10.80	IM6403 10.80

STATIC RAMS

1-16 17-63 64	
21L02 1.50	1.24 1.18
21L02 (350) 1.60	1.35 1.25
21L02 (250) 1.75	1.60 1.50
410D 10.75	10.00 9.25
101A 1.00	.90 .80
2101-1 2.95	2.75 2.60
2102 1.25	1.15 1.00
2111-1 3.95	3.50 3.25
2112-1 2.95	2.80 2.69
2114-3 11.00	10.00 9.25
2125L 11.00	9.00 8.30
2147 37.50	
31L01 2.50	2.35 2.00
1106 3.95	3.70 3.25
1107 3.95	3.70 3.25
TMS-4044 9.95	9.00 8.95
4200 A 12.95	
TMS-4045 11.00	10.00 9.25
5101 8.30	7.40 7.25
74C89 3.25	3.05 2.85
7489 2.25	2.10 1.90
745201 4.50	4.00 3.75
P8101 4.20	3.40 2.80
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P8156 21.00	18.00
8599 1.88	1.75 1.60
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full ASCII

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Model 756 K (kit)	\$49.95
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Model 710 Numeric Pad	\$9.95
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13 slot with front panel slot
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KIT \$80.00
22 Slot Assembled & Tested \$149.95

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DB-25P \$2.25	DB-25S \$3.25
COVER \$1.50	

44 Pin - PC & EYE	\$1.95
44 Pin - WW	\$2.50
86 Pin - (6800) PC	\$5.00
86 Pin - (COSMAC ELF) PC	\$5.00
100 Pin - (Altair) PC	\$4.50
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Includes Cabinet, Disc Drive, Power
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Has AC line filter.
Cabinet size 10"H x 10"W x 16"D
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JADE Floppy Disc (Tarbell Board)
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S.D. Computer Products
Versa Floppy Kit \$149.00 ea.

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Ram 8 (250ns)	\$169.95
Ram 8B (450ns)	\$139.95
250ns KIT Mem-1	\$169.95
450ns KIT Mem-1	\$125.00
BARE BOARD	\$25.00
16K Uses 2114L	
Ram 16 (250ns)	\$375.00
Ram 16B (450ns)	\$325.00
32K	
JG-32K (250ns)	\$875.00
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6800 Adapter for
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16K STATIC BOARD

with memory management can be used
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Systems. ASSEMBLED & TESTED
RAM 65(250ns) \$390.00
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with 1K RAM	
MR-16T (16K uses 2716) KIT	\$99.50
with 1K RAM	
MM-16 (16K uses 2708)	\$99.00
RAM/N/ROM (16K uses any E-PROM) KIT	\$117.00
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EXPANDABLE E-PROM - S.D.Sales	
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Allows you to use either 2708's for
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Power Supply +8v at 18amps
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Mother Board - 12 slots with
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S-100 Bus compatible
32 or 64 Characters per line - 16 lines
Graphics (128 x 48 matrix)
Parallel A composite video
On board low-power memory
Powerful software included for cursor,
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Black-on-white & White-on-black.

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* 2 Serial interfaces with RS232 inter-
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* Serial interfaces are crystal controlled
* Selectable baud rates.
* Cassette works up to 1200 baud.
* 1 parallel port.

S-100 Power Supply with Cabinet

Power supply +8v at 18 amps
±16v at 2 amps
Has connector for Power output
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tions calling for wide paper of unlimited length with the speed and reliability of electrostatic plotting.

The Vector Plotter is a multiple microprocessor based intelligent interface that offers the user several benefits by performing many of the functions formerly assigned to the host computer or a dedicated minicomputer, the most significant being the conversion of the vectors describing a plot into the raster area acceptable by the electrostatic plotter.

For more information contact Marketing Services, Gould, Inc., Instruments Div., 3631 Perkins Ave., Cleveland, OH 44144, (216) 361-3315.

CIRCLE INQUIRY NO. 135

Time Machine CT2400

CompuTime has introduced its latest S100 bus compatible product that is capable of doing most of the time related functions of a microcomputer system.

The Time Machine is just what its name implies. An easy to use product that features digital CLOCK/CALENDAR (2400 hour time, four year calendar); 3 programmable counters, 2 with 1us resolution, 1 with 1sec. resolution; programmable frequency and pulse width generator; programmable frequency pulse width measurement; interrupt capability from programmable counters; onboard TIME/DATE LED display and set switches; power loss battery backup option kit; optional kit for extending TIME/DATE LED display and set switches to a remote or front panel location; programmable in BASIC.

The Time Machine comes completely assembled and tested. Each order includes documentation, parts list and software examples. Price is \$185.00. For further information contact CompuTime, P.O. Box 417, Huntington Beach, CA 92648.

CIRCLE INQUIRY NO. 132

Caere Introduces New OCR Reader

Caere Corporation has developed a new Optical Character Recognition (OCR) system for multiple applications. The Series 600 features the Model 610 OCRReader™ with advanced capabilities in point-of-sale (POS) and other data entry applications such as order processing, inventory control, remittance processing, library systems, prescription records, check and credit card number processing, client aging files, product testing records, medical coding, policy number reading and countless other applications utilizing alpha/numeric methodology.



The handheld Model 610 can read up to 130 characters per second with a high degree of accuracy. Systems are available from Mr. Don Ivie, Vice-President of Marketing at Caere Corp., 345 E. Middlefield Rd., Mountain View, CA 94043, (415) 964-8900. Price per system is about \$1,500 for potential OEM customers.

CIRCLE INQUIRY NO. 133

Plessey Microsystems Adds DEC Add-On Capability to Its FFT Modules

A new addition to Plessey's FFT modules series offers complete compatibility with the Digital Equipment Corporation's PDP-11 and LSI-11 series computers.



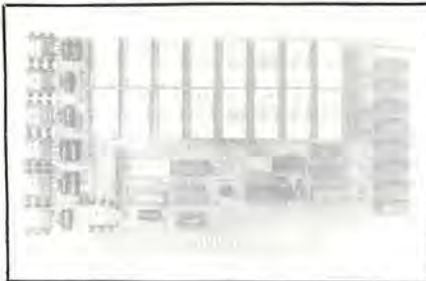
The new system, the Plessey SPM-02/11, offers decreased transform times when compared with software FFT's and complete independence from the host processor as it acts in parallel with the host. The SPM-02/11 is controlled completely from the host via a software library named FFT LIB. All functions including data capture and transform are controlled by the host.

The system price is \$9,200. F.O.B. Irvine, CA. Delivery is 60 days. For more information contact Plessey Microsystems, 1641 Kaiser, Irvine, CA 92714, (714) 540-9931.

CIRCLE INQUIRY NO. 138

RAM-N-ROM

The RAM-N-ROM board operates on the S100 bus and can be wired to accept any one of seven EPROMs. There are sockets for 16 ROMs and 1K of RAM on this board.



With this RAM-N-ROM board you can operate with one type of EPROM now and update the board to another EPROM type later.

The RNR-100 sells for \$168 assembled and \$117 in kit form. The kit comes complete* with sockets for all the ICs and all the materials required, including a manual. For more information contact Szerlip Enterprises, 1414 W. 259 St., Harbor City, CA 90701. *EPROMs are not included.

CIRCLE INQUIRY NO. 139

Switch Selectable 40/64 Column Printer

The CP-41 printer is a compact alphanumeric impact printer ideally suited for many small system needs.

Switch selectable line length allows printing of either 40 or 64 characters per line. Peak printing rate is in excess of 180 characters per second with an average throughput of 75 lines per minute.



The universal controller is compatible with all computer and terminal systems having an

8-bit parallel interface. The CP-41 can print the standard 64 ASCII character set and includes a full line buffer memory.

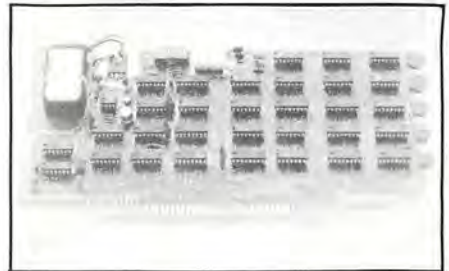
The model CP-41 is \$425, complete with standard 3 1/2" paper roll and ribbon. For more information contact Microcom Systems, 865 3rd St. South, St. Petersburg, FL 33701, (813) 823-0421.

CIRCLE INQUIRY NO. 136

New Clock Board

Expand your time-keeping capabilities with Mountain Hardware's new 100,000 Day Clock for S-100 computers.

Several unique features make this Clock an almost indispensable addition to your system. The Clock is crystal controlled for accuracy and an on-board, 9 volt rechargeable battery keeps your Clock ticking away during computer down times.



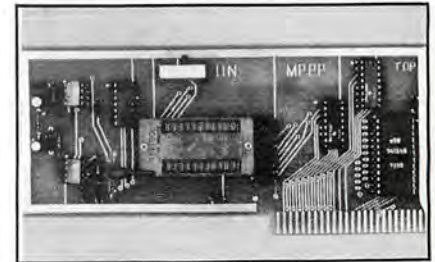
This versatile board keeps time in 100us increments for periods as long as 100,000 days, that's 273 years! An interrupt feature has been provided which can be programmed for any change in a Clock digit to help make efficient use of computer time.

Price of the 100,000 Day Clock is \$219 assembled and tested, \$179 in kit form. Delivery is stock to 30 days. For more information contact Mountain Hardware, Inc., 5523A Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-4734.

CIRCLE INQUIRY NO. 137

Apple II EPROM Programmer

Microproducts' new Apple II EPROM Programmer takes the lid off the capabilities of microprocessor permanent memory. The two empty ROM sockets can be filled with 4K bytes of user selected programs. No more loading of peripheral interfaces, assemblers or your favorite programs or games from tapes. Merely turn on your computer and go.



This programmer consists of a fully assembled, double sided, fiberglass printed circuit board with plated through holes and gold plated edge connector. It plugs directly into any available slot on your Apple II board. It contains a Textool zero insertion force socket for delicate handling of your valuable EPROM. This EPROM Programmer is fully self contained and has its own "on-board" 25 volt power supply for programming the Intel 2716 EPROM.

The price of the EPROM Programmer is \$89.95 and the Intel 2716 socket adapter is \$9.95. Available from your nearest Apple dealer or contact Microproducts, 1024 17th St., Hermosa Beach, CA 90254, (213) 374-1673.

CIRCLE INQUIRY NO. 149

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TDL Z16K STATIC MEMORY BOARD

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CIRCLE INQUIRY NO. 86

Long Life/Low Cost 80-Column Dot Matrix Printer Mechanism

Featuring a one-hundred-million character dot head, the new low-cost 80-column Model 3110 Dot Matrix Printer Mechanism offers OEM three times the present head life of mechanisms in its price. Range. It sells for less than \$250 in 500 quantities.

Long life of the head with ruby-jeweled support comes from the mechanism's precise alignment and pin movement.



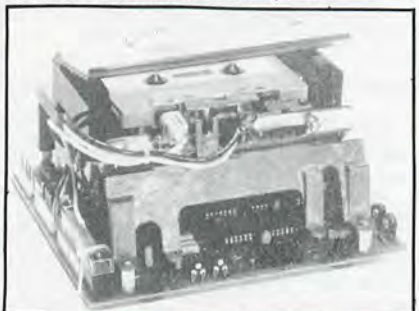
The Model 3110 prints 80 columns at 150 characters per second, with a 5x7 dot matrix character and 1/10 column spacing tailored for the small business and home computer markets.

A 40-column version of this mechanism is currently available, designated Model 512, for \$155 in 500 quantities. For additional information contact Epson America, Inc., 23844 Hawthorne Blvd., Torrance, CA 90505.

CIRCLE INQUIRY NO. 146

SELECTO-SYNC™

A major development in capstan speed control for Phi-Deck cassette tape transports, the Selecto-Sync system provides from 1/15 to 24 times the standard cassette speed.



This extraordinary range of synchronous speeds extends the usefulness of cassette recording for such diversified applications as extreme low speed data acquisition systems, low speed recording with high speed playback, high speed system loaders, directly synchronized multiple deck operations, high speed tape duplication, and critical timing operations.

For further information and prices contact Triple i's Applications Engineering Dept., 4605 N. Stiles, P.O. Box 18209, Oklahoma City, OK 73154, (405) 521-9000.

CIRCLE INQUIRY NO. 142

Card Reader for Label Printing

The Model 200 Card Reader is a device specifically tailored for data input into a Label Preparation System (LPS).

The unit reads 80-column tab cards at a speed of up to 285 a minute and transmits the punched information to the LPS Label Printer Unit. The data moves through a controller unit where it is edited and reformatted before being passed along for label printing.

The Model 200 Card Reader is ideal for use where label data requires more than 80 characters, since the unit can be programmed to read and transmit all data for a label regardless of the number of cards needed to hold it. Used as a free-standing batch mode

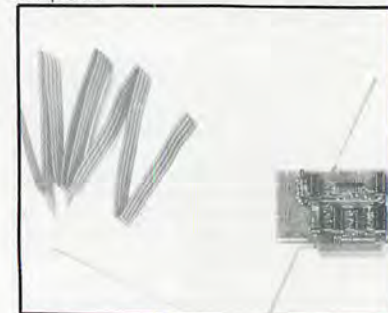
device, the unit provides an alternative to putting an LPS system on line to mainframe computer equipment.

The Model 200 Card Reader is available for \$6,950. Delivery is 90 days. For additional information contact the local sales office of The Standard Register Co., or J.A. Cornely, at corporate headquarters, P.O. Box 1167, Dayton, OH 45401.

CIRCLE INQUIRY NO. 141

Intelligent Parallel Printer Interface Card for Apple II

Apple Computer, Inc. has introduced the Model A2B0002X Intelligent Printer Interface (IPI) Card, second of a long line of intelligent peripherals planned for the Apple II Personal Computer.



The new parallel gives Apple II owners hard copy from any popular priced printer such as those offered by Axiom, Centronics, Qume, Printronics, OKI Data, SWTP and others, using the IPI. Apple owners can produce permanent copy of program listings, generate reports, print letters and labels and even generate graphics on printers with graphic capability.

The A2B0002X Intelligent Printer Interface Card is available from Apple dealers for \$180. The card comes with firmware in ROM, printer configuration block, ribbon cable and complete instruction manual.

For more information contact Apple Computer, Inc., 10260 Bandley Dr., Cupertino, CA 95014, (408) 996-1010, Steven Jobs.

CIRCLE INQUIRY NO. 129

Algorithmics PR-DW1 Precision Printer

The PR-DW1 Daisy Wheel Printer is a letter-quality printer unit designed for use with microcomputer systems for high-quality printing and plotting applications. This printer operates under control of an internal microprocessor and communicates with the host microprocessor over a high-speed asynchronous parallel interface.



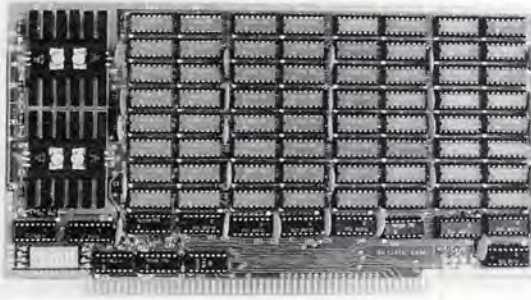
It prints bi-directionally at rates of 45 characters per second. Twenty-eight different typestyles are available on easily changed plastic and metal wheels. Cloth ribbons come in seven different colors including red/black combination. Carbon film ribbons are black.

Suggested retail price for the standard configuration including complete microcomputer interface and all software is \$2678. For more information contact Algorithmics Inc., Box 56, Newton Upper Falls, MA 02164, (617) 965-0545.

CIRCLE INQUIRY NO. 130

? Wondering which memory is best for you?

base 2 offers the following products to the S-100 market at the industry's lowest prices:



8K Static Memory Board

This 8K board is available in two versions. The 8KS-B operates at 450ns for use with 8080 and 8080A microprocessor systems and Z-80 systems operating at 2MHz. The 8KS-Z operates at 250ns and is suitable for use with Z-80 systems operating at 4MHz. Both kits feature factory fresh 2102's (low power on 8KS-B) and includes sockets for all IC's. Support logic is low power Schottky to minimize power consumption. Address and data lines are fully buffered and 4K bank addressing is DIP switch selectable. Memory Protect/Unprotect, selectable wait states and battery backup are also designed into the board. Circuit boards are solder masked and silk-screened for ease of construction. These kits are the best memory value on the market! Available from stock . . .

8KS-B \$125 (assembled and tested add \$25.00)

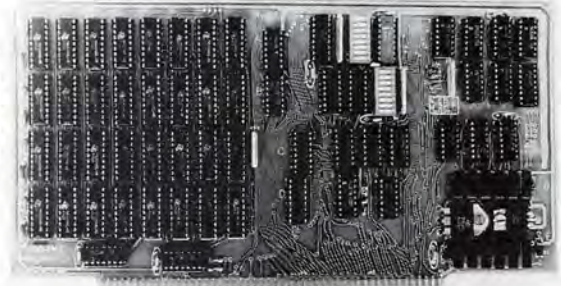
8KS-Z \$145 (assembled and tested add \$25.00)

16K Static Memory Board

Base 2 can now offer the same price/performance in a 16K static RAM as in its popular 8K RAM. This kit includes 8K bank addressing with 4K boundary address setting on DIP switches. This low power unit provides on-board bank selection for unlimited expansion . . . No MUX board required. Using highest quality boards and components we expect this kit to be one of the most popular units on the market. Available in two speed ranges, the 16KS-B operates at 450ns while the 16KS-Z operates at 250ns.

16KS-B \$285 (assembled and tested add \$25.00)

16KS-Z \$325 (assembled and tested add \$25.00)



Z-80 CPU Board

Our Z-80 card is also offered in two speed ranges. The CPZ-1 operates at 2MHz and the CPZ-2 operates at 4MHz. These cards offer the maximum in versatility at unbelievably low cost. A socket is included on the board for a 2708 EPROM which is addressable to any 4K boundary above 32K. The power-on jump feature can be selected to address any 4K boundary above 32K or the on-board 2708. An on-board run-stop flip-flop and optional generation of Memory Write allows the board to run with or without a front panel. The board can be selected to run in either the 8080 mode, to take advantage of existing software, or in the Z-80 mode for maximum efficiency. For use in existing systems, a wait state may be added to the M1 cycle, Memory request cycle, on-board ROM cycle, input cycle and output cycle. DMA grant tri-states all signals from the processor board. All this and more on top quality PC boards, fully socketed with fresh IC's. **CPZ-1 \$110 CPZ-2 \$125**

S-100 for Digital Group Systems

This kit offers, at long last, the ability to take advantage of S-100 products within your existing Digital Group mainframe. Once installed, up to four S-100 boards can be used in addition to the existing boards in the D.G. system. The system includes an "intelligent" mother board, ribbon cables to link existing D.G. CPU to the DGS-100 board and a power wiring harness. The DGS-100 is designed to fit in the 5-3/4" x 12" empty area in the standard D.G. cabinet. It may seem expensive but there's a lot here! End your frustration! **DGS-100 \$295**



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32K FOR \$475 EXPANDORAM KIT 24K FOR \$367.00

MEMORY CAPACITY MEMORY ADDRESSING MEMORY WRITE PROTECTION

8K, 16K, 24K, 32K using Mostek MK4115 with 8K boundaries and protection. Utilizes DIP switches. PC board comes with sockets for 32K operation. Orders now being accepted. Allow 6 to 8 weeks for delivery.



Buy an S100 compatible 8K Ram Board and upgrade the same board to a maximum of 32K in steps of 8K at your option by merely purchasing more ram chips from S.D. Sales! At a guaranteed price — Look at the features we have built into the board.

INTERFACE CAPABILITY

Control, data and address inputs utilizes low power Schottky devices.

POWER REQUIREMENTS

+8VDC 400MA DC
+18VDC 400MA DC
+18VDC 30MA DC

on board regulation is provided. On board (invisible) refresh is provided with no wait states or cycle stealing required.

MEMORY ACCESS TIME
IS 375ns.

Memory Cycle Time is 500ns.

16K FOR \$259.00

8K FOR \$151.00

Z-80 CPU BOARD KIT — \$139.

CHECK THE ADVANCED FEATURES OF OUR Z-80 CPU BOARD. Expanded set of 158 instructions, 8080A software capability, operation from a single 5VDC power supply, always stops on an M1 state, true sync generated on card (a real plus feature!), dynamic refresh and NMI available, either 2MHz or 4MHz operation, quality double sided plated through PC board, parts plus sockets priced for all IC's. *Add \$10 extra for Z-80A chip which allows 4MHz operation. Z-80 chip with Manual — 29.95



S.D. SALES NEW EXPANDABLE EPROM BOARD

16K or 32K EPROM \$49.95 w/out EPROM
Allows you to use either 2708's for 16K of
Epm or 2716's for 32K of Epm.

KIT FEATURES:

1. All address lines & data lines buffered.
2. Quality plated through P.C. Board, including solder mask and silk screen.
3. Selectable wait states.
4. On board regulation provided.
5. All sockets provided w/board.

WE CAN SUPPLY 450ns 2708's AT \$11.95
WHEN PURCHASED WITH BOARD.

4K LOW POWER RAM KIT

Fully Buffered — on board regulated —
reduced power consumption utilizing
low power 21L02 — 1 500ns RAMS —
Sockets provided for all IC's. Quality
plated through PC board. *Add \$10. for
250ns RAM operation.



The Whole Works - \$79.95

8K LOW POWER RAM — \$159.95

Fully assembled and tested.
Not a kit. Imsai — Altair —
S-100 Buss compatible, uses
low power static 21L02-500ns
fully buffered on board regulated,
quality plated through PC
board, including solder mask. 8
pos. dip switches for address
select.



250 ns Operation
\$189.95

6 DIGIT ALARM CLOCK KIT

Features: Litronix dual 1/2" displays, Mostek
50250 super clock chip, single I.C. segment
driver, SCR digit drivers. Kit includes all ne-
cessary parts (except case). Xfmr optional.
Eliminate the hassle.

AC XFMR — \$1.50 Case \$3.50 \$12.95

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4 JUMBO .50" DIGITS ON ONE STICK!
WITH COLONS & AM/PM INDICATOR

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NEW FROM S.D. "VERSAFLOPPY"™ KIT THE VERSATILE FLOPPY DISK CONTROLLER ONLY \$149.00

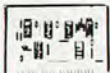
Features: IBM 3740 Soft Sectored Compatible, S-100 BNS Com-
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1. Shugart SA400/450 Mini Floppy.
2. Shugart SA800/850 Standard Floppy.
3. PERCISI 70 and 277.
4. MFE 700/750.
5. CDC 9404/9406.

34 Pin Connector for Mini Floppy. 50 Pin Connector for Standard
Floppy. Operates with modified CP/M operating system and
C-Basic Compiler.
The new "Versafloppy" from S.D. Computer Products provides
complete control for many of the available Floppy Disk Drives.
Both Mini and Full Size. At the heart of "Versafloppy" is the
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FD 1771B-1 CHIP ALONE \$39.95

Low Cost Cassette Interface Kit



Features: Play and record K.C. Standard 2400/1200 Hz
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Both 22 Pin Connector and 8 Pin Molex Connector.
Comes partially assembled. Oscillator and phase lock
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LED indicates logic 1 level.

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- E. Perfect for cars, boats, vans, etc.
- F. PC board and all parts (less case) inc.

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AC XFMR — \$1.50



\$16.95

RAMS

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1101A - 256	8/14 00
1103 - 1K	35
MK 4115 - 8K	15 45
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Z-80 includes manual	29 95
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8820 Dual Line Recr	1.75
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FD 1771B-1	39.95

CMOS

4001	19	4029	99
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4011	19	4047	1.50
4013	32	4049	35
4016	32	4059	23
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4022	97	14518	1.10
4024	75	14528	85
4027	39	14529	85

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Four-Disk Microsystem

The new system, Sol System IV, is an integrated small computer system with four full-size floppy disks on-line. It includes Processor Technology's Sol-20 mainframe with 50,176 8-bit words of RAM memory, a Heliod II Model 4 Disk Memory System, PTDOS Disk Operating System, Extended Disk BASIC, a video monitor and complete documentation. Total mass storage capability on four formatted disks is 1.5 million bytes.



The PTDOS Disk Operating System offers advanced functions including complex editors, assembler, device-independent files, and random indexed files.

In addition to Extended BASIC, Processor Technology offers Disk FORTRAN and Disk PILOT languages as low cost options. For complete information contact Processor Technology Corp., 7100 Johnson Industrial Dr., Pleasanton, CA 94566.

CIRCLE INQUIRY NO. 161

Quay 80 F1 S-100 Floppy Disk System

A floppy disk system for use in S-100 bus computers is available from Quay Corporation. The Quay 80 F1 system, priced at \$695 includes the Q/80 FDC-floppy disk controller board (capable of supporting up to four disks), QDOS-disk based operating system, and Q/FD1 125 KB 5 1/4" band-driven disk drive with power regulator and interface cable, and the Q/80 FC-floppy disk cabinet. Add-on drives (Q/FD1) are priced at \$350 each.

In addition to the floppy disk support, the Q/FDC has available a programmable 8-bit, TTL compatible, parallel I/O port capable of supporting standard peripheral devices such as line printers, tape punches, keyboards, etc.

Product availability is 30-60 days ARO. For more information contact Quay Corp., P.O. Box 386, Freehold, NJ 07728, (201) 681-8700.

CIRCLE INQUIRY NO. 163

DIVA Announces PDP® 11/70 Compatible Disk System

The DD 70 Series features a Computroller that will interface directly to the Digital Equipment Corporation PDP 11/70 computer and communicate directly with the Cache Bus Controller on the PDP 11/70. This new Series enables the user to take full advantage of the efficiencies of the PDP 11/70 cache architecture. The Cache Bus interface allows the disk system to transfer full 32 bit words directly into memory without Unibus intervention.

The DD 70 Series consists of the Computroller V, an intelligent microprocessor-based disk controller; a four-board PDP 11/70 interface, which plugs into the DEC machine in place of the DEC RH70 Massbus® Controller; and a choice of disk drives ranging in capacity from 80-300 megabytes per spindle.

This Series is a functional replacement for

the DEC RP04 or RP06 disk drives available from DEC. Systems are also available which provide for a 50% faster disk transfer rate than those presently available from DEC.

Utilizing a unique microprocessor-based emulation package, DIVA's disk system is software transparent to all standard DEC operating systems, thereby eliminating any need for foreign I/O drivers or any software or hardware modification on the user's PDP 11/70 system.

Single drive systems range in price from under \$22,000 to \$30,000 depending on drive capacity. For additional information, please contact Diva, Inc., 607 Industrial Way, Eatontown, NJ 07724, (201) 544-9000, (800) 631-2141, Dick.

CIRCLE INQUIRY NO. 158

Floppy Disk Capacities Raised with Two-Sided Models

Micropolis Corporation has announced the extended capacity of its 5 1/4-inch floppy disk subsystems with its first double-sided models with formatted file storage of up to nearly 2 million bytes.



The company's MegaFloppy series features an intelligent controller that facilitates interconnection of four subsystems to a common host interface for a total on-line storage capacity of more than 15 megabytes.

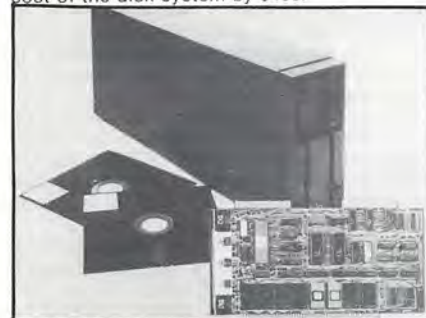
Double-sided versions will be implemented first on two OEM series — Model 1015 and Model 1055.

For more information and prices contact Micropolis Corp., 7959 Deering Ave., Canoga Park, CA 91304, (213) 703-1121.

CIRCLE INQUIRY NO. 157

New Floppy Disk System for All S-100 Bus Microcomputers

INFO 2000 Corporation has immediate availability of their new high-performance floppy disk system for S-100 bus microcomputers. The new disk system incorporates a controller board called DISCOMEM. This controller enables the manufacturer to offer much faster disk performance while lowering the overall cost of the disk system by \$400.



The S-100 disk system combines the PerSci Model 177 dual diskette drives with the INFO 2000 DISCOMEM Controller Board and the

Digital Research CP/M to provide all necessary hardware and software, when added to any S-100 bus computer, for immediate operation.

Cost of the complete dual-drive disk system, including all I/O facilities and CP/M is \$2,600. Another model, without the I/O, is \$2,450. Delivery is 2 weeks ARO. For more information contact INFO 2000 Corp., 20630 S. Leapwood Ave., Carson, CA 90746.

CIRCLE INQUIRY NO. 160

Disk System Upgrades Heathkit H8 to Z-80

INFO 2000 Corporation has available a complete disk system for Heathkit H8 computers. Now Heathkit H8 users may easily add the new disk system and simultaneously upgrade their 8080 computer to a Z-80 system by replacing the Heathkit 8080 CPU board with the INFO 2000 Z-80/Disk Adapter Board.



The complete INFO 2000 Disk System for the Heathkit H8 Computer includes PerSci Dual Diskette Drives, power supply, case, intelligent controller, adapter, cables and disk monitor in EPROM. The INFO 2000 Adapter Board contains the Z-80 microprocessor and all support chips, 7K of EPROM, 1K of scratchpad RAM for the Disk Monitor, and all necessary logic for interfacing the disk system to the Heathkit H8.

Cost for the complete INFO 2000 Disk System for Heathkit H8 is \$2,740. Delivery is 3-4 weeks ARO. For more information contact INFO 2000 Corp., 20630 S. Leapwood Ave., Carson, CA 90746, (213) 532-1702.

CIRCLE INQUIRY NO. 159

8" Floppy Disk System for SWTPC 6800

The Southwest Technical Products Corporation DMAF1 is a dual drive, single density, double sided 8" floppy disk system. The hardware consists of an SS-50 bus (SWTPC 6800) compatible DMA (direct memory access) controller capable of handling up to four drives, two CalComp 143M double density rated disk drives, 5 1/2"H x 17 1/2"W x 20 1/2"D aluminum chassis, regulated power supply, drive motor control board, cooling fan, diskette and interfacing cables.



The system is available in assembled and kit form (the drives themselves are fully assembled). The unit weighs approximately 45 lbs. and sells for \$2,095 assembled and \$2,000 as a kit plus postage.

For more information contact Southwest Technical Products Corp., 219 W. Rhapsody, San Antonio, TX 78216, (512) 344-0241.

CIRCLE INQUIRY NO. 164

Double-Sided, Double-Density Minidisk

Information Terminals Corporation has the Verbatim D² Minidisk, a 5.25-inch diameter double-sided, double-density diskette with data storage capacity of 0.6 to 1.0 megabytes, depending on formatting.

The D² Minidisk is compatible with Shugart and other dual-head Minidisk drives. The D² Minidisk is available in soft sector, 10-sector or 16-sector versions.

The new product contains an oxide formulated specifically for dual-drive applications. It is more durable, has greater data integrity and provides the most reliable formatting of any dual-sided diskette, using a write-compensation feature to improve initialization reliability. The D² Minidisk can safely withstand temperatures in excess of 125°F.

D² Minidisks are now being delivered. Each Minidisk is provided with a protective envelope in a ten-pack box.

For more information contact Information Terminals Corp., 232 Soquel Way, Sunnyvale, CA 94086.

CIRCLE INQUIRY NO. 166

PerSci's New Four-Headed Voice Coil Floppy

PerSci's "four-headed" flexible disk drive will store up to 3.2 Mbytes of data in the space required by a standard size floppy drive. The new PerSci Model 299 Diskette Drive, interfacing to 8080, 6800 and Z-80 based systems as well as minicomputers, provides the basis for a low cost, independent data management system.



The Model 299 is a dual-headed, dual diskette drive reading and writing both sides of two 8" diskettes. Data can be encoded in single or double density in IBM compatible soft sector formats or expanded hard and soft sector formats on IBM Diskette I, II, IID or equivalent media. The drive will store up to 1 Mbyte of data in IBM type format, 1.6 Mbytes unformatted single density and up to 3.2 Mbytes in unformatted double density encoding.

The price is \$1,595 in single unit quantity. OEM discounts available. Delivery is second quarter 1978. For more information contact PerSci, Inc., 12210 Nebraska Ave., W. Los Angeles, CA 90025, (213) 820-3764.

CIRCLE INQUIRY NO. 162

Rigid Disk Drives

Shugart Associates has announced their first rigid disk drive products. The SA4000 fixed disk drives are available in 14.5 and 29 mbyte (unformatted) capacities with an optional 144 kbytes of additional head-per-track storage. The drives utilize industry-proven Winchester read/write head and media technology.



The 14.5 mbyte drive sells for \$2,550 in quantity one, and \$1,325 in quantity 250. The 29 mbyte version sells for \$3,500 and \$1,800 in the same quantities. The head-per-track option is \$350. Full quantity OEM discounts are available. For more information contact Shugart Associates, 415 Oakmead Pkwy., Sunnyvale, CA 94086, (408) 733-0100.

CIRCLE INQUIRY NO. 152

1.6 Megabyte Floppy Disk System

Datronics has an 800 K byte and 1.6 M byte S-100 floppy disk storage system. Based on the PerSci Model 277 drive with voice coil head positioning, this system offers more storage in a standard size drive than most other currently available drives.

The 800 K byte model is a single density drive system, while the others employ dual-density recording techniques. The S-100 controller is processor independent, and can be used with most 8080, 8085, Z-80 and 6802 based systems as well as with the Datronics 6800 CPU (S-100 based). Several formats are allowed, including IBM 3740.

Software included with the systems is written for the 6800, but 8080 (8085 and Z-80) versions will be available soon. Termed SDOS, this Disk Operating System offers full dynamic file allocation and file maintenance. That means that data or program files may expand or shrink as needed with all necessary housekeeping being totally transparent to the user.

SWTPC (SS-50) and Digital Group Bus-Compatible systems are now available. Several 6800 based Business languages and complete 6800 Business packages are also available.

Complete systems start at \$1999 (includes drive, case with fan and power supply, controller, cable and SDOS on disk). Availability is stock to 4 weeks. For more information, contact Datronics, 208 W. Olive, Lamar, CO 81052, (303) 336-7956.

CIRCLE INQUIRY NO. 155

Double-Sided, Double-Density Diskette

Information Terminals Corporation has a double-sided, double-density diskette containing a new oxide formulation specifically designed for dual-head applications.

Designated Verbatim D², the new diskette has been qualified for use with IBM 5110, System 34 and Series 1, Shugart 850/851 and other OEM dual-sided diskette drives.

The D² diskette stores over 1.2 million bytes of data, depending on format. ITC supplies preformatted diskettes for all IBM diskette drives and provides custom-formatted diskettes to OEM customers. Hard sector and unsectored D² diskettes are also available.

The D² diskette sets new standards in durability and data integrity due to a completely new oxide formulation. Format reliability has been ensured by utilizing a compensation feature during initialization. The D² can safely withstand temperatures in excess of 125°F.

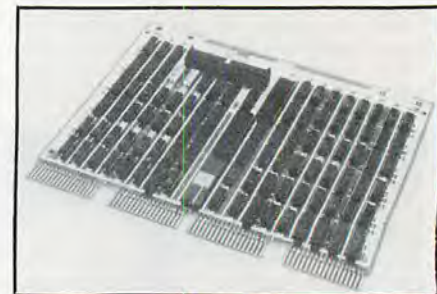
D² diskettes are now being delivered. Each diskette is provided with a protective envelope in a ten-pack box.

For more information contact Information Terminals Corp., 323 Soquel Way, Sunnyvale, CA 94086.

CIRCLE INQUIRY NO. 165

Single Board Cartridge Disk Controller

The DILOG-1 single Quad board cartridge disk controller couples from 2.4 to 80 megabytes of storage to Digital Equipment Corporation's PDP1103/11V03 and other LSI-11 based computer systems. Software transparent with D.E.C. RK11 disk systems, the DILOG-1 controller operates under RT-11 and RSX-11 operating systems. The single board design incorporates a microprocessor to reduce component count and thus reduce costs.

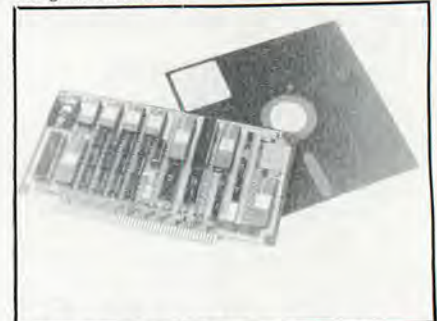


All DILOG-1 controllers are supplied with diagnostic software and an instruction manual. Quantity 24 price is \$1,995. Delivery is 30 days. For more information contact Distributed LOGIC Corp., 12800 "G" Garden Grove Blvd., Garden Grove, CA 92643, (714) 534-8950.

CIRCLE INQUIRY NO. 156

Intelligent Diskette Controller

PerSci's new Z-80 based double density diskette drive controller, among the first designed for full IBM diskette 2D, IBM 3740 and S-100 bus compatibility, is a stand-alone intelligent controller.



The PerSci Model 1170 is significant in that it is capable of managing either single or double density recording on as many as 32 diskette sides for a remarkable total system formatted data capacity of 16 Mbytes.

The price is \$800 in OEM quantity. Delivery is 60-90 days ARO. For more information contact PerSci, Inc., 12210 Nebraska Ave., W. Los Angeles, CA 90025, (213) 820-3764.

CIRCLE INQUIRY NO. 151

Hard Disk

Intel® Multibus® compatible 10 meg. hard disk system with multi-user D.O.S. Intelligent DMA controller can expand up to 40 megabytes using Ampex 440 series disk drives (IBM 5440 fixed/removable). Multi-uer D.O.S. (supports as many as 20-30 terminals) is multi-tasking/multi-sessioning and comes with fast multi-user compilative BASIC. (Hardware floating point capabilities are optional as is a program development package which produces assembly relocatable code.)

The D.O.S. permits the use of passwords, protect codes and 15 levels of file protect, and keeps track of each user with respect to CPU time, real time, and disk-I/O requests. Hard disk system and multi-user D.O.S. also available separately.

For more information contact Computer Systems Unlimited, P.O. Box 870, Milpitas, CA 95035, (408) 262-6271.

CIRCLE INQUIRY NO. 154

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- ★ Requires no front panel
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IMS 16K STATIC RAM

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- ★ Address 16K Bound
- ★ Use with or w/o front panel
- ★ Power 2.1 amps typ.
- ★ Uses 2114

ASSEMBLED & TESTED only
450ns. \$439.95 250ns. \$495.95

S-100 32K STATIC RAM

- ★ Address 32K Boundary
- ★ Power 450ns. 2.8 amps typ.
- ★ No wait states on 2MHz
- ★ Fully Buffered
- ★ Phantom can be added
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8 Pin S/T	17	40 Pin S/T	63

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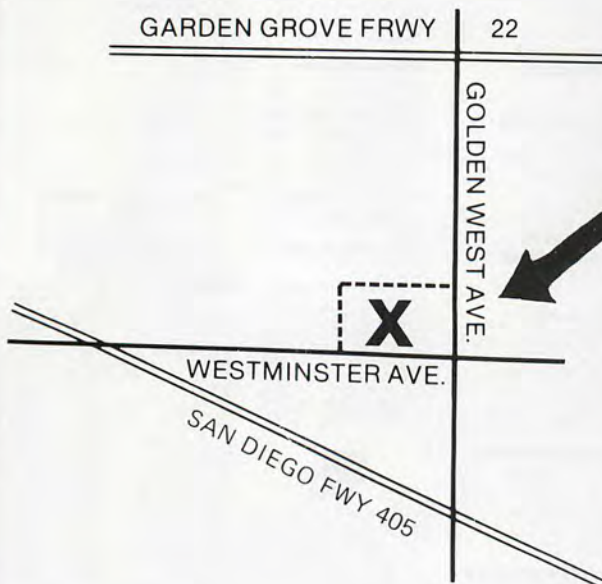
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Terminals

DEC VT-52 Compatible CRT

The DEC VT-52[®] compatible alphanumeric CRT is a low-cost, applications-oriented video terminal. The Elite 3052A offers formatting capability, eight levels of screen enhancements, and a detached keyboard to make it one of the best price-performing video terminals available.



The terminal is priced at \$1,700 in single quantities and at \$1,360 in quantities of 100. For more information contact Datamedia Corp., 7300 N. Crescent Blvd., Pennsauken, NJ 08110, (609) 665-2382.

CIRCLE INQUIRY NO. 171
Adcat Terminal

Itas, Inc. has available its new Adcat Terminal, an Optical Mark Reader and Printer. The Adcat Terminal offers high speed optical mark reading and the ability to print up to 360 characters under computer control on the same document... all in a few seconds.



The Adcat Terminal is simple to use and takes up about the same amount of space as an office typewriter. The terminal was designed for use by people with no computer experience and no typing skills. It is an on-line, transaction-oriented terminal and is used in applications such as inventory and production control, student registration, test scoring, payroll calculation, time reporting, market research, etc.

Price is \$2,990. Quantity discount available. Delivery is 30-60 days. For more information contact Itas, Inc., 8 Fairchild Ct., Plainview, NY 11803, (516) 822-7711.

CIRCLE INQUIRY NO. 170

Megatek Introduces Intelligent Graphic Display

The new Megagraphic 7000 Series of intelligent refresh graphic systems and terminals feature longer graphic word length, a 32-bit bipolar, bit-sliced microprocessor, self-con-

tained refresh memory, a more versatile interface and advanced expandable hardware. The new interactive system is said to deliver performance available only in machines costing 40 percent more.



A new interface enables the Megagraphic 7000 to be connected to DEC PDP-11 computers in addition to Data General's Nova and Eclipse with which the existing Megagraphic 5000 is compatible. The advanced hardware features allow the addition of such optional features as rotation, zoom, scale and clip in addition to standard features such as hardware blink, translation and dashed lines.

The Megagraphic 7000 is currently in production and can be shipped within 60-90 days ARO. Prices start at \$20-\$25K, FOB factory, San Diego. For more information contact Megatek Corp., 1055 Shafter St., San Diego, CA 92106, (714) 224-2721, Peter Shaw.

CIRCLE INQUIRY NO. 174

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ASCII SELECTRIC

Printer Mechanism: Heavy duty input/output, Series 745.

Weight: 120 lbs. Dimensions: 29"Hx35"Wx33"D. Print Speed: (14.8 characters per second)

Platen: 15" wide, pin feed or form feed device optional (132 print positions).

Parallel output only—15 characters per second accepts 7 bit ASCII parallel w/strobe & prints on Selectric. The unit still works as a typewriter in off-line mode.

DATL SELECTRIC (IBM Selectric Mechanism)



Specifications:

- Size: 21"Wx21"Dx8"H.
- Power Input 115 Volt Hz
- Interface: RS232
- Weight: 54 lbs. (Shipping weight 65 lbs.)
- 15" Carriage
- 15 CPS
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1,000 Line Color Monitors

Ramtek Corporation has a new, 1,000 line color monitor for use with graphics and imagery display systems. The new monitors feature ultrahigh resolution of 1280 x 1024 pixel addressability with a bright, color display.



The Ramtek 1,000 line monitors offer both cost and performance advantages to a wide variety of display users including military, aerospace, medical, computer-aided design, command and control, satellite communications, weather mapping, and other sophisticated color graphics and imaging applications.

For more information contact Ramtek Corp., 585 N. Mary Ave., Sunnyvale, CA 94086, (408) 735-8400, Mrs. Beverly Toms.

CIRCLE INQUIRY NO. 167

MFE 2500 Buffered Cassette Terminal

MFE Corporation is now offering a new addition to its line of Buffered Data Cassette Terminals, the Model 2500.

The Model 2500 incorporates MFE's New Model 450B Tape Drive, which allows recording on both sides of the tape, for an unequalled 350,000 character capacity.



ANSI compatible, the MFE 2500 is available with TI or NCR compatibility, selectable rates up to 2400 baud, and a Binary Mode. Also standard are TTY and RS-232C interfaces.

With most of the features of their present MFE 5000, the Model 2500 has greater storage at a much reduced price.

A microprocessor-based system, the Model 2500 single quantity price is \$1,190, with distributor discounts available. For more information contact MFE Corp., Keewaydin Dr., Salem, NH 03079, (603) 893-1921, Bruce Swander, Product Manager.

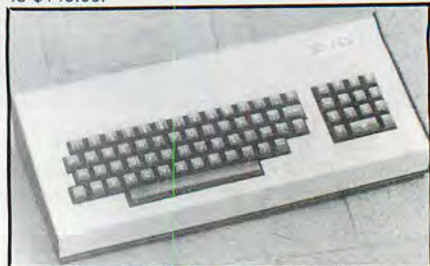
CIRCLE INQUIRY NO. 175

MKB-2 Keyboard

The new MKB-2 Keyboard by MicroAge, designed for use with the new 64 and 80 character display video boards, combines the most popular keyboard features with a low affordable price.

Included as standard in the MKB-2 are a numeric key pad, upper and lower case, cursor control keys, 2-key rollover, and auto repeat on all keys. Plus, the MKB-2 is assembled in a heavy duty steel case with parallel interface, strobe or pulse, on-board regulation (5v, 12v), complete with standard DB25S connector, and

black double-injection molded keys. List price is \$149.00.



For more information contact MicroAge, 1425 W. 12th Place, #101, Tempe, AZ 85281, (602) 967-1421, W. Craig Tenney.

CIRCLE INQUIRY NO. 169

Combinational Keyboard — \$64.00

Ten keys fit naturally under the fingertips and operated in combinations much as a piano is played. The keyboard permits entry of ASCII, Rowcode, EBCDIC, or a code of your own. No encoder required. A total of 1023 characters is possible.



For one-handed operation the left thumb key is moved and interleaved with the right thumb key. The right thumb then operates either or both keys — permitting one-handed entry of 63 characters. The unit uses a parallel input port of an Altair or equivalent system. Learning to use the keyboard is easy for both the experienced typist and novice.

Try the keyboard for 16 days. If you're not satisfied, return for a full refund. CCIC, 4719 Squire Dr., Indianapolis, IN 46241.

CIRCLE INQUIRY NO. 172

New Handheld Terminal

MSI Data Corporation has a new handheld data entry terminal with a segmented memory which makes it the equivalent of several terminals in one.



Features of the MSI/88 are a 16-digit LED display and bar code wand scanning capability for the Universal Product Code and the MSI code.

MSI will soon provide the capability for the MSI/88 to scan the Codabar™ code and the new European Article Numbering (EAN) system, the European equivalent of the Universal Product Code.

For more information contact MSI Data Corp., 340 Fischer Ave., Costa Mesa, CA 92626, (213) 393-0622, Richard Roper.

CIRCLE INQUIRY NO. 173

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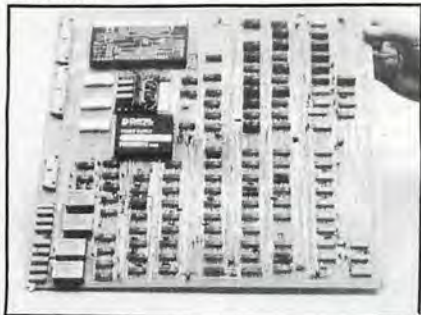
MISSION CONTROL

CIRCLE INQUIRY NO. 87

I/O Cards

64-Channel A/D-D/A Interface/Peripheral

The ST-NOVA series is a complete A/D-D/A data acquisition peripheral built on a single PC board which slides directly inside Data General NOVA series minicomputers. The ST-NOVA uses the +5VDC power from the computer backplane and generates its own $\pm 15V$ for analog circuits using an on-board DC/DC converter.



The ST-NOVA accepts 64 single-ended or 32 differential input channels and digitizes them to 12-bit binary data words. These data samples are then placed on the NOVA bus by the assembly language program instructions on the diagnostic tape. Input voltages of -10V to +10V and other high level ranges may be accepted.

The A/D conversion uses Datel's hybrid ADC-HZ A/D converters with a fast conversion speed of 20 microseconds. Effective channel throughput rates of 45,000 samples per second using supplied DMA logic are possible.

The basic ST-NOVA board with 64 A/D channels is \$1445.00 single quantity, including program and manual. The addition of 4 D/A output channels is an extra \$350.00. Delivery is 6 to 8 weeks ARO. For more information contact Datel Systems, Inc., 1020 Turnpike St., Canton, MA 02021, (617) 828-8000, ext. 158, Ronald Petrelli, Systems Application Manager.

CIRCLE INQUIRY NO. 190

Datel Introduces New Video A/D Converter

Datel's new model ADC-TV is an 8-bit (48 dB) analog to digital converter with a conversion rate of 20 MHz. The ADC-TV is manufactured with standard off-the-shelf IC and hybrid circuits and employs a unique new building block concept. It is ideal for video applications such as digital time base correctors, frame synchronizers, special effects processors, and digital radar systems.



Digital and analog connections are made through a 37-pin subminiature "D" connector and a 3 mm terminated coax connector. Either ECL or TTL can be chosen as well as various input termination impedances.

Priced from \$1995.00 each, the ADC-TV8B is packaged in a 7.5 x 4.25 x 0.875" anodized aluminum case. For more information contact

Datel Systems, Inc., 1020 Turnpike St., Canton, MA 02021, (617) 828-8000, ext. 141, Eugene Murphy, Applications Engineer.

CIRCLE INQUIRY NO. 189

Low Cost RS-232C Fiberoptic Data Link

Designed as a "turn-key" system, the Model RSH-D1 is an asynchronous full duplex link which can handle data rates to 20 KBPS.

A standard, 25-pin, computer type connector is used for electrical input and output signals. Fiberoptic connectors are mounted on the link which mate directly to Valtec's PC-10 fiberoptic duplex cable. Transmission to 300 feet (100 meters) is standard.



The computer user now has a system for fiberoptic transmission at an affordable price. The Model RSH-D1 has been especially designed for distributed data processing installations while providing EMI immunity and ease of cable installation.

Price for a link pair is \$1,000 with 4 week delivery. Full duplex fiberoptic cable is priced at \$1.00 per foot. For more information contact J. Morris Weinberg, Valtec Corp., West Boylston, MA 01583, (617) 835-6082.

CIRCLE INQUIRY NO. 194

12-bit Analog Input Module Is Pin Compatible with Popular Microprocessors

The MP22 is an analog input module that interfaces directly with 8080A, 8048, Z-80 and SC/MP microprocessors. With minimal external logic it is compatible with 6800, 650X, F8 and 8085 microprocessors, and also with PDP-8, PDP-11, NOVA and ECLIPSE minicomputers.



This self-contained unit consists of a 12-bit A/D converter, instrumentation amplifier, input multiplexer, address decoder and control logic. Interrupt, halt and direct memory access request signals are generated by internal logic. MP22 accepts 16 single-ended or 8 differential analog signals and the system can digitize low or high level inputs.

Price is \$245 (1-9) and delivery from stock. For more information contact Steve Harward, Product Manager, Burr-Brown, International Airport Industrial Park, Tucson, AZ 85734, (602) 294-1431.

CIRCLE INQUIRY NO. 188

Voice Input for Apple II

A new voice data input unit for the popular Apple II computer, known as Speechlab Model 20A, is available at computer stores and directly from the manufacturer for \$189.00, assembled and tested.



Included in the price is a high fidelity microphone and a user manual with six demonstration programs (including Mastermind, Blackjack, and Shooting Stars) written in Apple BASIC illustrating the use and capabilities of the unit.

Speechlab Model 20A features a 32-word vocabulary, fast real time response, and the capability of multiple training samples for high accuracy.

For more information contact Heuristics Inc., 900 N. San Antonio Rd., Los Altos, CA 94022, (415) 948-2542.

CIRCLE INQUIRY NO. 191

Micro Module Has 16 Keys and 15 Displays

The new WINCE Console I/O Module provides a versatile but inexpensive means of communication between a human operator and a microprocessor. A 16-key keyboard allows entry of parameters such as product codes, gas chromatograph stream select, etc. and 15 7-segment displays allow output of data such as torque, item counts, etc.



Also included is a real time clock for providing interrupts and displaying time. The Console I/O and the other 12 Wince Micro Modules are unique in that they are the largest family of 6800 microprocessor and interfacing modules on industry standard 4 1/2" x 6 1/2" 44-pin cards.

For more information contact Wintek Corp., 902 N. 9th St., Lafayette, IN 47904, (317) 742-6802.

CIRCLE INQUIRY NO. 195

CDC 300 LPM Printer for PDP-11, RT-11 or RSX-11M

Advanced Computer Data Systems, Inc. (ACDS) is now offering the Control Data Corporation 300 LPM Printer as a package to end users and OEM's of Digital Equipment Corporation PDP-11 series computers.

The \$9,900 package includes an interface/controller card and a software driver to run



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BYTE-8

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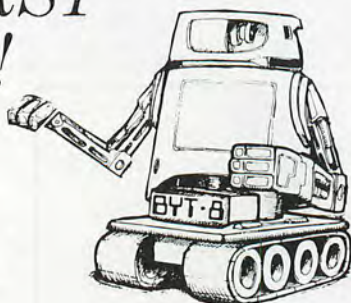
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CIRCLE INQUIRY NO. 72

under DEC's RT-11 or RSX-11M operating systems. The printer includes an RS-232 interface with a 1K buffer, paper basket, selectable forms length, 6/8 lines/inch, LED Diagnostics, paper motion detection, an acoustic cabinet with pedestal and a 64-character print band (ASCII Coding).

Optional are 48-, 96- or 128-character sets with corresponding increases and decreases in printing speeds by merely changing print bands. A compressed font option is also available for \$400 giving 15 characters/inch capability instead of the normal 10 characters/inch, which allows a 132-character-wide report to print on 11 inch wide paper.

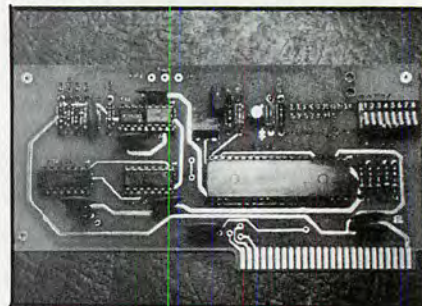
For more information contact ACDS, 210 25th Ave. N, Nashville, TN 37203.

CIRCLE INQUIRY NO. 187

Serial I/O for the Apple II

Electronic Systems has a serial I/O board for the Apple II that comes with software for: input and output of basic programs and monitor to a teletype or other serial device, and a program for using the Apple II for a video terminal.

Input and output are RS-232. The board has switch selectable parity, number of stop bits, and jumper selectable address. Data rate to 30,000 baud.



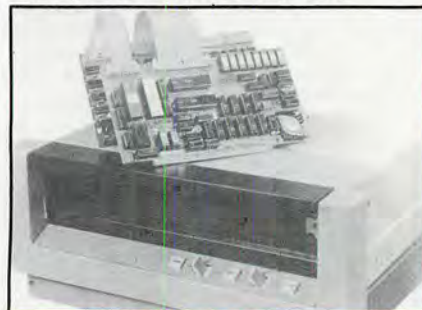
The serial I/O is available as an assembled and tested unit for \$62, or kit with parts for \$42.00, or circuit board only for \$15.00.

For more information contact Electronic Systems, P.O. Box 9641, San Jose, CA 95157, (408) 374-5984.

CIRCLE INQUIRY NO. 180

Disk Controller

The Crea/Comp Intelligent Hard Disk Controller (DC-2000) is designed to be associated with the S-100 bus and to mate to any of the CPU's adapted thereto. It is a "true" intelligent disk controller, containing its own Z80 intelligence, which is used to control disk operations and to provide an onboard data base.



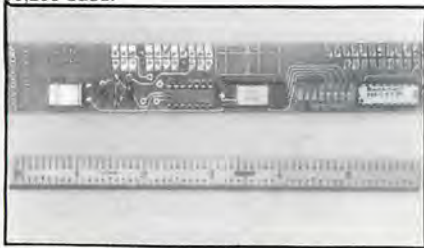
The host requests the controller to read or write a record on file, and the work is done by the controller, leaving the host free to carry on the simultaneous and independent actions of multiple users. The CreaComp Intelligent Hard Disk Controller is compatible with several disk drives, providing between 5 megabits and 1.2 billion bytes of storage.

For further information contact CreaComp Systems, Inc., 4175 Veterans Memorial Hwy., Ronkonkoma, NY 11779.

CIRCLE INQUIRY NO. 178

Nova/Eclipse Baud Rate Generator

Nova/Eclipse users having non-adjustable Data General I/O boards may implement the back plane mounted Baud Rate Generator to obtain 2 independently adjustable, crystal controlled baud rates through a range of 50 to 19,200 baud.



Typical applications will allow users to connect various terminals with differing baud rates to the Nova/Eclipse I/O boards and switch select matching baud rates as desired.

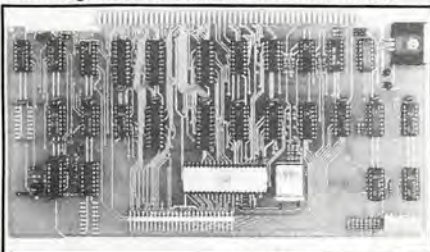
The Baud Rate Generator is a dual baud rate generator with one of the baud rates committed to a specific back plane pin for internal use on the I/O board. The second totally independent baud rate generator permits the use of baud rates in other portions of a system which may require different baud rates.

The Baud Rate Generator Adapter is \$125. Delivery is stock. For more information contact California Data Corp., 3475 Old Conejo Rd., Suite C10, Newbury Park, CA 91320, (805) 498-3651.

CIRCLE INQUIRY NO. 179

S-100 MPA

The S-100 MPA is an S-100 bus adapter for the Commodore PET computer. This S-100 sized card plugs into the user's mainframe and a cable connects to the PET allowing the use of the wide range of peripheral and memory cards available for the S-100 bus. The S-100 MPA (Memory and Peripherals Adapter) is unique in that it emulates the true S-100 bus including full DMA, true PSYNC generation, I/O address mirroring, read wait states and much more.



An important feature of this board is that it can also act as a stand-alone 6502 CPU board for the S-100 bus. It is truly S-100 bus compatible. A simple option kit is all that is required.

The S-100 MPA is available in kit form for \$199.95 or fully assembled and tested for \$279.95. The Stand-Alone Processor option is an additional \$49.95. The S-100 MPA is available at computer dealers or direct from HUH Electronics. Delivery is from stock to 3 weeks. Dealer discounts are available.

For more information contact HUH Electronics, 1429 Maple St., San Mateo, CA 94402, (415) 573-7359.

CIRCLE INQUIRY NO. 182

Texas Instruments Announces Two Quadruple Bus Transceivers

Two quadruple bus transceivers, the AM26S10 and AM26S11, are a second source for Advanced Micro Devices bus transceivers with the same designations.

These quadruple bus transceivers utilize Schottky-diode-clamped transistors for high speed. The drivers feature open-collector outputs capable of sinking 100mA at 0.8 volts maximum. Driver and strobe inputs use p-n-p transistors to reduce input loading.

The driver of the AM26S10 is inverting and

the driver of the AM26S11 is noninverting. Each device has two ground connections for improved ground current-handling capability. For proper operation, the two ground pins should be tied together.

The AM26S10C and AM26S11C are characterized for operation from 0° to 70°C. Both devices are offered in 16-pin plastic and ceramic DIP (N and J suffixes). Prices in 100-piece quantities are \$1.60 for the AM26S10CN and AM26S11CN, and \$1.87 for the AM26S10CJ and AM26S11CJ.

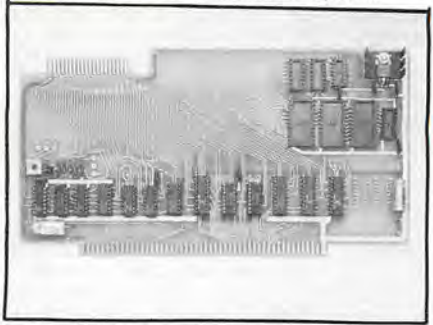
For more information contact Texas Instruments, Inc., Inquiry Answering Service, P.O. Box 5012, M/S 308 (Attn: AM26S10), Dallas, TX 75222.

CIRCLE INQUIRY NO. 192

TRS-80 to S-100 Adapter

Mini Micro Mart has available an Adapter Board for the popular Tandy TRS-80 computer system to permit using it with the industry

standard S-100 bus. The adapter board is connected to the TRS-80 interface port with a ribbon cable, and the adapter board plugs into any standard S-100 backplane or system.



In addition to converting signals from the Tandy Z-80 bus to S-100 signals, the board also provides for on-board PROMs or ROMs and for

SAVE up to \$1300 on the Ultimate Computer... a complete Cromemco SYSTEM THREE!



Use the SYSTEM THREE for business and accounting, word processing, data-base management, science and engineering, legal and medical, and for classroom applications.

Your complete SYSTEM THREE includes: the Z80 microcomputer, PerSci dual disk drives, standard 32K of memory, and standard serial and parallel interfacing.

Included is the CRT terminal which displays highly legible characters at 80 characters per line and a 24-line page in upper and lower case. Text editing and a separate numeric keypad with cursor positioning are standard.

The high speed line printer, also standard with the SYSTEM THREE, features 180 characters per second, 132 column width, and tractor feed with adjustable forms sizes.

The entire system is factory assembled and tested. A typical system can be leased for as little as \$280 per month.

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CIRCLE INQUIRY NO. 98

INTERFACE AGE 135

a power on jump to anywhere in the memory map (with an inexpensive accessory).

All S-100 bus accessories are not support, but, in general, any board that will function with an S-100 bus Z-80 CPU board will also function with this adapter. Power for the adapter board comes from the S-100 host bus.

For details write to Mini Micro Mart, Inc., 1618 James St., Syracuse, NY 13203, (315) 422-4467.

CIRCLE INQUIRY NO. 184

MICRO-VERTER

Micro-Verter is a new concept in computer video-to-RF modulator interfaces. By operating on the UHF channels above Channel 14 (as opposed to conventional modulators which run on channels 2-6), it is able to overcome a common problem known as low-band "worming."



The Micro-Verter interfaces directly with the Apple II and most other microcomputers. It is tunable over a minimum of four UHF channels. It comes housed in a two-tones decorator cabinet complete with video cable, connectors and RF output stub coupler, less batteries.

No assembly required except battery installation. \$35.00. For further details contact ATV Research, 13-1 Broadway, Dakota City, NE 68731, (402) 987-3771, Mel Shadbolt.

CIRCLE INQUIRY NO. 176

Technical Design Labs Introduces the VDB (Video Display Board)

The VDB is a video interface for the S-100 bus microcomputers. The VDB is low in cost and yet provides the capabilities of video terminals costing thousands of dollars more. It consists of two boards, one piggybacked to the other. The unit occupies one edge connector on the bus, but takes up the space of two boards.

The VDB contains its own display buffer memory and provides two pages of display, each with 25 rows of 80-characters. The display buffer memory does not use any memory address, thus leaving the entire computer memory address intact for user programs.

This new product displays, in addition to the 96 upper and lower case ASCII characters with descenders, 64 unique display symbols, thus permitting a graphic resolution with 160 hori-



zontal elements by 75 vertical elements. The display can accept data at a 400,000 character per second rate.

The VDB works with either modified TV sets or monitor and has an on-board 8-bit parallel keyboard port with status strobes. The VDB requires one motherboard socket and occupies two card spaces.

The VDB is priced at \$369.00, fully assembled and tested. Software character and graphics output drivers for Z80™ and 8080 systems are supplied. These drivers are ROMable.

For additional information contact Judy Goodman, Public Relations, Research Park, Bldg. H, 1101 State Rd., Princeton, NJ 08540, (609) 921-0321.

CIRCLE INQUIRY NO. 193

Camac Interface Board for I.C. Pluggable Wire-Wrap Use

The Camac Interface boards are plug-compatible with the Camac standard instrumentation bus. The Garry Camac boards provide 38 universal rows of 64 socket/terminals per row with ground and voltage terminals between every other row, spaced .300 inch.



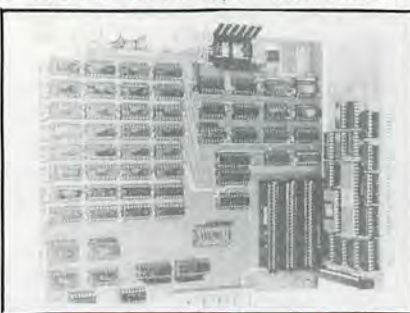
These boards will accommodate up to 125 sixteen-position I.C. chips or an equivalent mix of 14, 16, 18, 22, 24, 36 or 40-position LSI chips.

The new boards are available on two to four-week delivery at prices ranging from \$2.00 to \$3.00 per I.C. position. For more information contact Garry Manufacturing Co., 1010 Jersey Ave., New Brunswick, NJ 08902, (201) 545-2424, Harry Koppel, Exec. Vice President.

CIRCLE INQUIRY NO. 181

Expandapet

The Expandapet is an expansion system for the Commodore PET or other 6502-based computer. It provides in one convenient assembly which can be mounted inside the PET: 16K of RAM (additional 8 or 16K of RAM optional), 4K of EPROM, two complete parallel I/O ports with handshake. The unit contains its own DC power supply and sockets for three additional expansion modules such as Serial I/O Board, S-100 Driver Board or Experimenter's Board.



The standard unit, priced at \$435, comes ready-built and tested with 16K of RAM, sockets for 4K of EPROM, 2 parallel I/O ports and necessary cables and brackets to mount inside the PET. An adapter for the KIM is also available.

For more information, contact Convenience Living Systems, 648 Sheraton Dr., Sunnyvale, CA 94087, (408) 733-0688.

CIRCLE INQUIRY NO. 177

COSMAC S-100 Interface

Infinite Incorporated has developed and tested an interface to the S-100 bus.

The company is making this information available to industry in the form of an engineering package containing schematics as well as signal and component descriptions. The package provides all the information needed to implement the COSMAC 1802 - S-100 interface.

The engineering package is presently being included with the purchase of the company's UC1800 training and development microcomputer. The comprehensive package is also available separately on a prepaid basis for \$9.95. For more information contact Infinite Inc., 1924 Waverly Pl., Melbourne, FL 32901.

CIRCLE INQUIRY NO. 183

Vector Graphic Introduces Video Display Board

The FLASHWRITER™ video display board requires only +Vdc at 1.2 amps. The Flashwriter will generate a video display of 1024 characters — 16 lines x 64 characters, and uses a 7x9 dot matrix to produce an extremely high quality, high resolution display image.



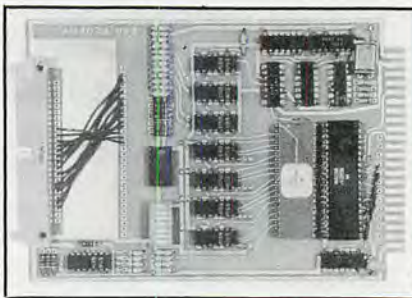
The Flashwriter is fully compatible with most S-100 bus microcomputers. Its video output conforms to RS-170 requirements and is available as composite video or separate video and sync.

Available completely assembled and tested for \$235 or in kit form at \$195 from all authorized Vector Graphic dealers. For more information contact Yvonne Beck, Vector Graphic Inc., 790 Hampshire Rd., Westlake Village, CA 91361, (805) 497-6853.

CIRCLE INQUIRY NO. 185

Floppy Controller Uses New Motorola Chip

Wintek Corporation has incorporated the new Motorola MCM 6843 floppy disk controller IC into a low cost but extremely versatile and powerful floppy disk controller.



The 4½" x 6½" module interfaces to any full size or mini floppy disk drive. The module supports both hard and soft sectoring, IBM 3740 or user programmable read/write format, automatic CRC generation/checking, and programmable step and settling times.

\$199 unit price. For more information contact Wintek Corp., 902 N. 9th St., Lafayette, IN 47904; (317) 742-6802.

CIRCLE INQUIRY NO. 186

Memory Cards

MaxiRAM Storage System

The MaxiRAM System provides maximum throughput with random access capability. It also provides a maximum access time of 1.5 microseconds, with a transfer rate of 625,000 words/second. It assures zero latency; and, with a built-in controller, it assures total transparency to the host computer.



With modular capacity ranging from 0.524 megabytes to 8.388 megabytes, the MaxiRAM System offers considerable flexibility. Each 19" chassis accepts up to eight pluggable modules of 524K bytes each. A second chassis may be interconnected, providing up to 8.388 megabytes through one controller.

For more information contact Roy Norman, Imperial Technology, Inc., 831 S. Douglas St., Suite 102, El Segundo, CA 90245, (213) 679-9501.

CIRCLE INQUIRY NO. 198

S-100 Card Holds and Programs 2716, 2708 PROMs

A maximum of eight TMS 2716 or 2708 PROMs (16K or 8K bytes maximum) are held on Objective Design's new PROM board — the DATABANK. The board will also program these PROMs via two special on-board sockets. (The second socket provides access to an external programming station.) Each of the eight PROMs may be individually switched into or out of the system address space. Further, the entire board can be disabled or enabled by I/O commands.

In addition to the PROM, the board will hold 1K or 2K of RAM. The RAM will operate as bus memory or can be substituted (by software command) for any of the PROMs. A PROM in the programming socket also has this substitution ability. This permits a user to copy a PROM set or attempt a change in the existing program without moving or changing any PROMs. All programming voltages are provided by the DATABANK board circuitry.

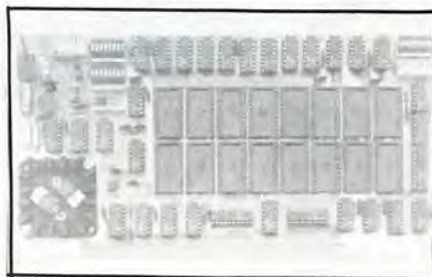
For further information, contact Objective Design, Inc., P.O. Box 20325, Tallahassee, FL 32304.

CIRCLE INQUIRY NO. 205

32K Bytesaver[®] Memory Board with 2716 PROM Programmer

Cromemco's 32K Bytesaver card provides an on-board 2716 PROM programmer. Information can be stored quickly and permanently by a simple, one-time write of the desired data into an erased PROM with the on-board programmer turned on. The card also provides a full 32

kilobyte capacity of non-volatile storage for ROM-intensive applications.



The 32K Bytesaver is designed for use with the industry-standard S-100 bus and is compatible with Cromemco's System Two and System Three computers.

The card is available in kit form for \$195 and assembled and tested for \$295. For additional information contact Cromemco, Inc., 280 Bernardo Ave., Mountain View, CA 94040, (415) 964-7400.

CIRCLE INQUIRY NO. 196

PEM-8K External Memory

PET 2001 owners wanting to expand their system without modifying their computer will be interested in the PEM-8K External Memory. This stand alone unit supplied an additional 8K of external memory compatible with either the 4K or 8K version of the PET 2001 series. Connection to the computer's existing memory is

Apple II and Centronics—an unbeatable pair.



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Saturday 10 - 6

CIRCLE INQUIRY NO. 70

made through a three foot interface cable and an edge connector plug that mates with the PET's memory expansion connector.



A self-contained, fused and regulated power supply furnishes all necessary operating voltages. Power is controlled by a rear-mounted switch.

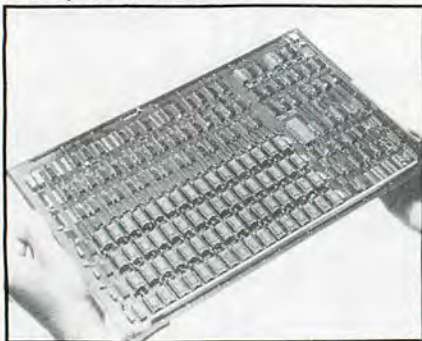
The PEM-8K is shipped fully assembled and ready for immediate use. Price is \$279. For more information contact International Technical Systems, Inc., Box 264, Woodbridge, VA 22194.

CIRCLE INQUIRY NO. 200

Refresh Memory Adds 4-Bit Resolution to Graphic CRTs

The in-5770 refresh memory system provides four-bit resolution to the picture elements (pixels) of video images projected onto raster-scan CRT display terminals.

The system is mounted on one 11.25 by 16 inch edge-connector-type printed-circuit board, and utilizes Intel 16-pin, 16K MOS dynamic RAMs. It has a total capacity of 256K four-bit words organized into four image planes each 256K by one bit wide.



Pricing for the 512 x 512 board is \$3,400 in single quantity while the 256 x 512 board price is \$2,400 in single quantity. Delivery is 30 days ARO. For more information contact Intel Memory Systems, 1302 N. Mathilda Ave., Sunnyvale, CA 94086, (408) 745-7120, Connie Magne.

CIRCLE INQUIRY NO. 199

S-100 Card Features 8279, 8259

A new S-100 card from Objective Design, Inc. is designed to function as the basis for special function S-100 computers. The Console Interface Board contains an 8279 for interfacing switches and keypads as well as up to 32 seven-segment displays; an 8259 which generates "call" type interrupts to any location in memory; up to 6K of PROM (TMS 2716); 256 bytes of RAM; a real time clock, based on a 10 MHz crystal oscillator, with selectable interrupt intervals from 100 usec to 100 ms; a power-on jump whose address is programmed

in one of the PROMs; and optional on-board generation of MWRITE.

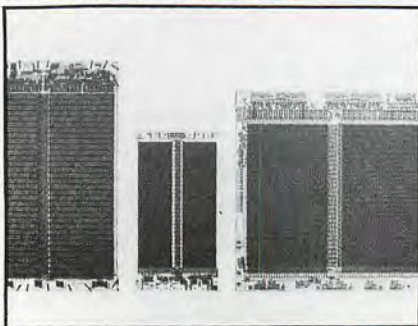
The board is available in several configurations, with firmware which includes interrupt service routines, Time of Year and general timed alarms, drivers for the 8279, and computer console functions.

For further information contact Objective Design, Inc., P.O. Box 20325, Tallahassee, FL 32304.

CIRCLE INQUIRY NO. 204

Highspeed 2114 Replacement and Bipolar-speed VMOS RAM

American Microsystems, Inc. has two new fully static 4,096-bit RAMs fabricated by the AMI-proprietary VMOS process.



Intended for microprocessor applications where higher speed is desirable, the new SMI S2114 VMOS RAM (1,024 x 4-bit) is a higher speed pin-compatible replacement for the Intel 2114.

The new AMI S4017 VMOS RAM (4096 x 1-bit) features the industry standard 18-pin 4K x 1 pinout with separate flexibility input and output pins to provide maximum design flexibility.

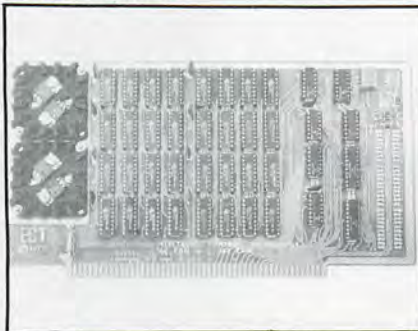
The S2114 and S4017 RAMs are supplied in 18-pin plastic and ceramic packages. Standard operating temperature range is 0-70°C. Prices for the S2114-2 are \$14.55 for plastic and \$17.00 for ceramic in quantities of 100 pieces. The S4017 is priced at \$30.00 for ceramic and \$24.60 for plastic in quantities of 100 pieces.

For more information contact Tom Edel, Mgr. of Marketing Services, American Microsystems, Inc., 3800 Homestead Rd., Santa Clara, CA 95051, (408) 246-0330.

CIRCLE INQUIRY NO. 202

16K RAM Fully Static Memory

Electronic Control Technology's 16K RAM memory board is a fully static S-100 bus memory board which utilizes a 4K fully static memory IC (TMS-4044) like the 21L02 except that it has four times the capacity per IC package and less power per bit.



Being fully static eliminates the incompatibility with DMA devices or other devices which sometimes occurs with dynamic or clocked static memory. All signals to MOS devices are buffered by low power TTL to prevent damage by static electricity and to minimize capacitive loading on the bus. Low profile IC

sockets are provided for all ICs. The board has a solder mask and a silk-screened legend. 2MHz operation is standard and 4MHz is optional at a slightly higher price.

The 16K RAM memory board kit is \$350. For more information contact Electronic Control Technology, 763 Ramsey Ave., Hillside, NJ 07205, (201) 686-800.

CIRCLE INQUIRY NO. 197

Monolithic Memories Approved by DESC as "QPL-II" Supplier of 2K Bipolar PROMs

Monolithic Memories, Inc., has received QPL-II (Qualified Products List) approval for its 2048-bit Schottky bipolar PROM from the Defense Electronics Supply Center (DESC) in Dayton, Ohio.

The 2K PROMs are available in both military flatpack and dual-in-line packages. For customers ordering these circuits, MMI's Federal Supply Code (FSC) number is 50364, and its manufacturer's designated symbol is "CECD."

For more information contact Paul Franklin at Monolithic Memories, 1165 E. Arques Ave., Sunnyvale, CA 94086, (408) 739-3535, ext. 124.

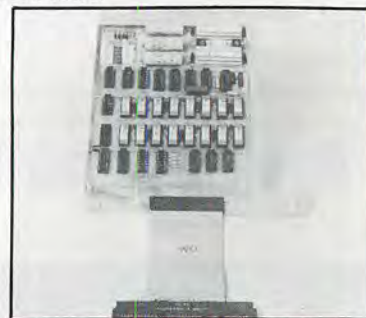
CIRCLE INQUIRY NO. 201

Memory Expansion for PET

PET STORE® is a plug-in memory expansion module for the Commodore PET computer.

It is available in 16K, 24K and 32K bytes of memory and is completely mounted within the PET's case.

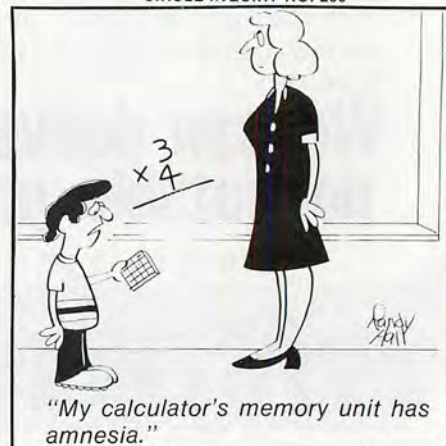
PET STORE has been designed with very low-power memory chips, and therefore is capable of being powered by the existing transformer of the computer without degradation of performance of the computer power supply or circuit board.



PET STORE can be mounted within the PET chassis and connected to the circuit board within a few minutes. No disassembly of the PET is required and all mounting hardware and cable is supplied.

PET STORE comes as an assembled and tested unit and has a six month warranty. The memory board is priced at \$550 for the 16K version, \$650 for the 24K version, and \$750 for the 32K version. For more information contact Computer Mart of New York, Inc., 118 Madison Ave., New York, NY 10016, (212) 686-7923.

CIRCLE INQUIRY NO. 203



Test Equipment

Portable Datascopes for Field Troubleshooting

Spectron Corporation has two new lightweight, portable Datascope data communications test instruments for use in field troubleshooting. The two new models — D-301 and D-302 — feature large storage capacity and speeds up to 72Kbps (D-301) and 2.5 megabits per second (D-302).



Both new units feature a large, all-electronic buffer in place of tape, and a lightweight, readily portable package for easy field use.

Purchase price of the D-301 Datascope is \$6,800; the D-302 is \$11,200. Availability for the units is 60 days and 120 days ARO respectively. For more information contact Spectron Corp., 344 New Albany Rd., Moorestown, NJ 08057, (609) 234-5700.

CIRCLE INQUIRY NO. 208

New Technical-Manager's Tool Kit

Designated the JTK-95, the kit contains more than 40 tools selected to perform a wide range of service and repair tasks. Included are pliers, cutters, screwdrivers, nutdrivers, wrenches, soldering equipment and much more. Most of the tools are mounted on a single pallet in a handsome attache-style tool case with a rich simulated reptile skin cover.



The bottom of the case is free of partitions, so when the tool pallet is removed, the case can be used as a regular attache case. The case features an expanding document pouch, solid brass hardware, and a combination lock as well as a key lock on one latch.

For more information contact Jensen Tools and Alloys, 1230 S. Priest Dr., Tempe, AZ 85281, (602) 968-6231.

CIRCLE INQUIRY NO. 209

On-Line Testing under IMS Now Available

Chicago Data Systems, Inc., has available TEST/IMS, a full facility, on-line program testing system for IMS. TEST/IMS supports 'session' testing, thereby allowing many different, unrelated program errors to be identified in a single test session, resulting in an increase in programmer productivity.

TEST/IMS provides a comprehensive method of isolating the test and production environments to ensure overall system reliability

and security. TEST/IMS allows IMS/TP programs to be tested in the real T/P environment, nothing is simulated. It also supports IMS/batch program testing and provides the same complete, concise information required for quick accurate debugging.

TEST/IMS requires far less CPU and peripheral resources and is a viable alternative for replacement of BTS or BTSII. For more information contact John A. Ambler, Chicago Data Systems, Inc., 2805 Butterfield Rd., Oak Brook, IL 60521, (312) 325-2960.

CIRCLE INQUIRY NO. 222

Biomation Unveils Logic Analyzer with Unique Display Outputs

The 9100-D is a logic analyzer with unique user oriented, versatile display outputs for bench and field service applications. The new unit is a useful tool for the telephony and computer industry field service, and for high speed control logic design.



The 9100-D provides nine channels at 100 MHz, a 1024 bit per channel memory and built-in combinational triggering and latch mode functions.

For more information contact Biomation Corp., 4600 Old Ironsides Dr., Santa Clara, CA 95050, Ed Jacklitch, (408) 988-6800.

CIRCLE INQUIRY NO. 223

New Personality Card for the 6800

A series of microprocessor personality cards for its MicroSystem Analyzer, Millennium Systems, Inc. enables users of Motorola's 6800 to perform inexpensive hardware/software integration and fault diagnosis of products employing this popular microprocessor.



When used at the design stage, the MicroSystem Analyzer frees costly microprocessor development systems for other tasks. The same MicroSystem Analyzer can be employed for functional testing and fault diagnosis in both production test and field service applications.

The price of the EM-6800 personality card is \$895. The basic MicroSystem Analyzer in unit quantities sells for \$1495. Delivery is 30 days ARO. For more information contact Marty Weisberg, Millennium Systems, 19020 Pruneridge Ave., Cupertino, CA 95104, (408) 996-9109.

CIRCLE INQUIRY NO. 206

Self-Programmable Logic State Analyzer

The 32-channel Model 532 Intelligent Logic State Analyzer is capable of programming itself for automatic operation. Using an Auxiliary Memory Board which plugs directly into the analyzer's internal bus, the Model 532 can store 8 individual tests: one in RAM and seven in UV PROMs.



The RAM position of the Auxiliary Memory Board can be used for remote testing when the Model 532 is configured with its RS-232 or IEEE-488 interface boards.

The Model 532 has a base price of \$1,500. The Auxiliary Memory Board, the RS-232 and IEEE-488 interfaces, and other options add \$150 to \$300. Delivery is 6 weeks. For more information contact Paratronics, Inc., 800 Charcot Ave., San Jose, CA 95131, (408) 263-2252.

CIRCLE INQUIRY NO. 207

CSC LP-2 Logic Probe

The most economical of the three logic probes in Continental Specialties' *The Logical Force™* is the versatile, inexpensive multi-family LP-2.

The LP-2 boasts a 300,000 Ohm output impedance; separate HIGH and LOW LED logic state readouts; switch-selectable DTL/TTL or HTL/CMOS operation; and a pulse-stretching PULSE-readout LED that responds with a blink to single pulses as fast as 300 nsec, and flashes at a 3 Hz rate to pulse trains up to 1.5 MHz.



Power is drawn from the circuit under investigation. Probe tips and power connectors are interchangeable with optional accessory configurations.

The LP-2 Logic Probe is available at electronics dealers and distributors worldwide or direct from the factory. Price is \$24.95. For further information contact Continental Specialties Corp., 70 Fulton Ter., New Haven, CT 06509; (203) 624-3103.

CIRCLE INQUIRY NO. 225

Transient Voltage Suppressor

A new line of HDA Power Master Transient Voltage Suppressors from W.N. Phillips, Inc. dissipates destructive electrical transients produced by changing loads, switching SCR drive systems, and operation of most electrical equipment.



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HDA Power Master lessens maintenance and down time, lowers motor operating temperatures, extends solenoid life, improves electronic component life and protects delicate computer circuits.

Featuring new solid-state semi-conductor components which produce responses within pico seconds, HDA Power Master units are available in voltages from 120-240 volt single phase to 480 volt 3 phase. Other features include fused protection, high energy dissipation and an operating temperature range of -25 + 75°C. Units are easily installed and are U.L. listed.

For more information contact Director of Marketing, W.N. Phillips, Inc., 356 Bacon St., Lake City, MI 49651, (616) 839-7181.

CIRCLE INQUIRY NO. 226

New Optical Colorimeter Uses Sphere Geometry for Color Measurement

The MC1010S is a complete actual color and appearance measurement system that allows inter-instrument agreement between colorimeters and between colorimeter and spectrophotometer. With the MC1010S the measurements taken at the control site by the colorimeter will conform to the measurements determined at the central laboratory or formulation facility.



The unit is engineered to be used where the need for color and appearance control is important. For more information contact Marketing Mgr., Color Data Products, Macbeth, Little Britain Rd., Drawer 950, Newburgh, NY 12250, (914) 561-7300.

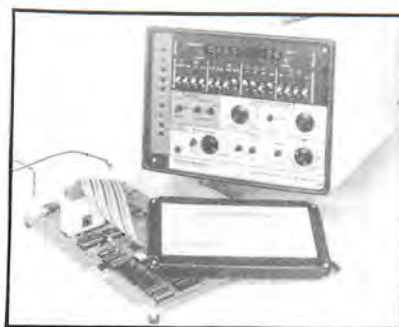
CIRCLE INQUIRY NO. 216

8080 Microprocessor System Analyzer

The AQ8080 Microprocessor System Analyzer, a low cost alternative to in-circuit emulators and CRT analyzers, is a cost effective, self-contained, portable instrument compatible with all 8080 system configurations.

A fully buffered 40 pin clip-on probe connects the AQ8080 directly to the microprocessor chip under test.

The independent hardware design of the AQ8080 offers compatibility with all system configurations as it does not require memory allocation, address or I/O port assignment, special clock, or a separate terminal. Built-in controls and displays permit the user to examine or modify all memory locations, I/O ports, and internal microprocessor registers, including the program counter and the stack pointer.



Price of the AQ8080, complete with buffered probe, is \$2250; delivery is stock to 45 days. For more information contact AQ Systems, Inc., 1736 Front St., Yorktown Hts., NY 10598, (914) 962-4264.

CIRCLE INQUIRY NO. 224

4 1/2 Digit DPMs

Designed to be totally compatible in microprocessor and instrumentation applications, the Series 600 4 1/2-digit Digital Panel Meter offers a variety of features including multiplexed BCD output; true ratiometric operation; run/hold command input; strobe and busy output; display blank and lamp test inputs; and ± 12 Vdc @ 5mA output.



Options include blank board that allows addition of special circuits with the DPM package and a choice of 120/240 VAC, 50/60Hz power input or a tristat parallel BCD buffer.

Price of the Series 600 is \$125 in unit quantities and delivery is stock to 4 weeks. For more information contact Dr. Otto Fest, International Microtronics Corp., 4016 E. Tennessee St., Tucson, AZ 85714, (602) 748-7900.

CIRCLE INQUIRY NO. 217

Logic Analyzer for 16-Bit Computer Systems

The Model LA1850 is a logic analyzer which captures 18 channels of data at speeds up to 50MHz. Designed to simplify the multi-component limitations of existing analyzers, the LA1850 features an integral display formatter, which allows the user to study timing and mapping displays or binary, HEX or octal data on any oscilloscope or monitor.



The LA1850 analyzer provides 18 channels of 510-word-deep unlatched or latched data storage, plus three additional qualifiers.

The instrument allows positive or negative logic formatting and incorporates cursor and trigger markers, synchronous and asynchro-

nous capturing of signals and dual thresholds with ECL, TTL and variable settings.

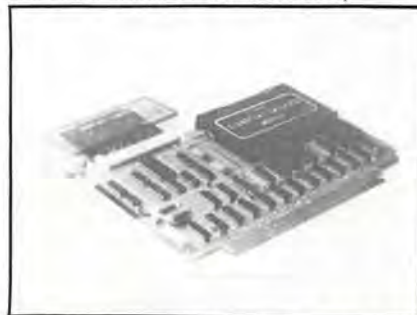
The EH Model LA1850 is available from stock or within 60 days for \$6,100 in the U.S.A. For more information contact EH International, Inc., 515 Eleventh St., P.O. Box 1289, Oakland, CA 94604, (415) 834-3030.

CIRCLE INQUIRY NO. 210

Digital Signature Controller

LS-100 Series Digital Signature Analysis product family provides the foundation for discrete, LSI and microprocessor circuit troubleshooting and repair.

Verification of correct digital patterns provides GO 1/2 NO-GO testing as well as diagnostics. 99.99% error detection accuracy; rapid identification of bad components, PC boards and entire systems becomes a reality.



Options include remote LED Signature Display, 32-line Multiplexer, logic probes, enhanced software package and stand alone test ability.

Applications include home computers, industrial and process control, product characterization and product testing.

The LS-100 expandable series is available in S-100, LSI-11, EXORciser bus compatible plug-ins, ready to go. From \$295, delivery is 30 days. For more information contact Phoenix Digital Corp., P.O. Box 11628, Phoenix, AZ 85017, (602) 996-8262.

CIRCLE INQUIRY NO. 214

IC Decoupling Plane/Position Identifier

The Model 706-1011-01-04-00 Decoupling Plane/Position Identifier provides discreet decoupling for an individual IC. The new plane can be tied to any voltage level on the board to provide unique decoupling characteristics required for specific circuits.



When used as a Position Identifier, this device will show exactly where an IC should be inserted in an array of contacts. This is particularly helpful in low density circuits on larger boards and panels.

For more information contact Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, MA 02138, (617) 491-5400.

CIRCLE INQUIRY NO. 211

The Third Hand

"The Third Hand™" is a sturdy aluminum circuit board holder of unique design featuring one hand operation. Clamped to the edge of the workbench it holds the board at a convenient angle for placing parts and then is flipped forward to solder parts in place.



The vinyl gasket protects the board from damage while holding it securely in place. The open end design allows it to hold circuit boards of any size. Can be left on bench without taking up valuable working space.

Retail price is \$9.95. Available from local dealer or Studio 3, P.O. Box 1184, Kailua, HI 96734.

CIRCLE INQUIRY NO. 213

Servo Controller for Single or Dual Bridge Load Cells

The Cyber Systems Model 9410 Servo Controller contains all the necessary hardware for providing closed loop electro-hydraulic control of applied loads.



The Model 9410 is a sensible controller, designed with a balance of analog and digital techniques, each applied to proper circuit functions. It is designed with built-in circuits for calibration, excitation and redundant limit checking.

For more information contact Dan Gincig, Cyber Systems, Inc., 2031 E. Cerritos Ave., Anaheim, CA 92806, (714) 772-2051.

CIRCLE INQUIRY NO. 221

Digital Thermometer for Industrial and Commercial Applications

Easy, pushbutton operation, a large, bright display of readings and 1°F accuracy from -40° to 200°F or the centigrade equivalent are provided in this new digital thermometer.



The Model 160 F1FCN has an integral 3½ inch long conical penetration tip probe for measuring temperatures of all solids, liquids, gasses and air. The unit is ruggedly built, battery-powered, solid-state with no moving parts and suitable for factory use.

Price is \$79.95. Other models featuring top probe mounted on 30-inch cable or telescopic air probe are available for under \$100. For more information contact General Scientific Equipment Co., Limekiln Pike and Williams Ave., Philadelphia, PA 19150.

CIRCLE INQUIRY NO. 218

New Color-Coded Instrument Probes

The B&K-Precision Model PR-37 instrument probe is available in gray or red colors. The PR-37 Deluxe Probe is designed for use with test instruments such as oscilloscopes and frequency counters to 100MHz. The PR-37 is a slim-body probe of precision light-weight construction.



A three-position switch selects 10:1 or direct modes, or a reference position that grounds the tip through a nine-megohm resistor.

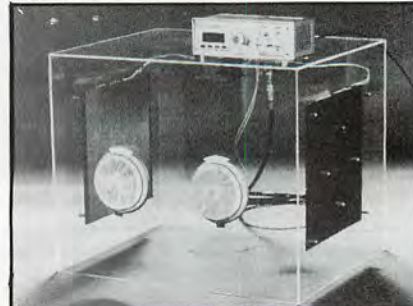
The PR-37G (gray) and PR-37R (red) are available for immediate delivery at local distributors and are priced at \$38.50 each. For more information contact B&K-Precision, Dynascan Corp., 6460 W. Cortland, Chicago, IL 60635, (312) 889-9087.

CIRCLE INQUIRY NO. 220

Portable Temperature Chamber

Minarco's new temperature chamber was specifically designed for electronic equipment evaluation and reliability insurance.

The unit features the temperature displayed on a half-inch, 3½ digit readout. Temperature is accurately controlled to $\pm 1^\circ\text{C}$ from -60° to 130°C .



A transparent, lightweight, portable chamber affords maximum visual and physical ac-

cess to the device inside. Over-temperature alarm provides audio and visual output as well as a rear panel signal for unmonitored protection of the device under test. The controller can be operated as a stand-alone digital thermometer. The unit also features zero crossing voltage mode for heating and operator-variable CO₂ rate control for cooling.

For more information contact Minntronics Co., Inc., Minarco Div., Dir. of Marketing, 2599 White Bear Ave., St. Paul, MN 55109, (612) 770-5247.

CIRCLE INQUIRY NO. 215

Miniature Reusable Impact Recorder

The patented G-Mini is a miniature bidirectional impact recorder that can be attached to product or packaging to record potentially damaging blows, jolts or dropping actions that exceed tolerable limits.



Two mass spring systems are used to sense the impact acceleration ("G" force loads) bidirectionally. G-Mini's can be selected from stock in ranges of 5, 10, 15, 25 and 50 "G" ranges to match the ruggedness of the product or its packaging limitations.

Smaller and thinner than a book of matches, G-Mini's can be placed unnoticeably on or within a product or packaging to aid in monitoring in-transit abuse and hidden damage. G-Mini's are also applicable to product testing and determining packaging design before shipment.

G-Mini's are sold for \$5.00 and come with technical data covering a multitude of applications. For more information contact Vexilar, Inc., 9345 Penn Ave. So., Minneapolis, MN 55431.

CIRCLE INQUIRY NO. 212

Wave Form Function Generator

The Model 350 Precision Low Frequency Generator is a digitally synthesized waveform function generator. The unit uses a crystal controlled clock and digital synthesis techniques to generate Sine, Square, Triangle, Ramp, Haver-sine, Haver-square, Haver-triangle and inverted waveforms.



The Model 350 has nine frequency ranges with three digit resolution providing an overall frequency range of 10 nanoHz (3.17 years) to 999Hz.

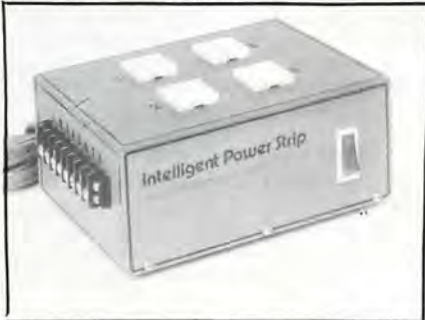
The basic Model 350 is priced at \$1,400, FOB Hillsboro, OR. Delivery is 60 days ARO. For more information contact Joe Foster, Exact Electronics Inc., 455 S.E. 2nd Ave., Hillsboro, OR 97123, (503) 648-6661.

CIRCLE INQUIRY NO. 219

Power Supplies

Intelligent Power Strip

The Intelligent Power Strip allows a computer to control up to four high power devices. TTL logic level lines make interfacing with a computer simple. The IPS allows phase control, letting software control motor speeds and dim lights. It also allows simple ON/OFF control and random or zero voltage switching of all common household appliances.



One of the power outlets provides the IPS the capability of allowing the driving computer to turn itself off. All inputs from the computer are optically decoupled to protect the computer hardware. Full protection against power failure and voltage surges is also provided.

The IPS sells for \$129.50 and comes fully assembled with a 5-foot power cord and an applications manual. For more information contact Research Computer Systems, P.O. Box 1214, Richardson, TX 75080.

CIRCLE INQUIRY NO. 233

Power Supplies for Non-Volatile Memory

The DS151 series of switching power supplies are designed especially for small computer and other manufacturers' marketing products utilizing non-volatile memories.



The DS151 series features a power fail signal as a standard feature. Should a power failure of one half cycle occur, the TTL compatible power fail signal wards the computer that primary AC power has been lost. This allows the designer to provide for storing his program in non-volatile memory. The power supply is designed to continue providing energy to the computer during the transfer period, which can usually be accomplished in milliseconds.

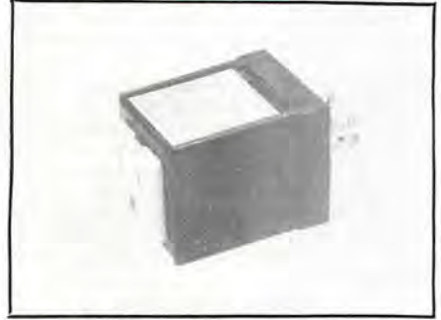
The power fail series is priced at \$194 in production quantities. Prototype quantities are available at \$289 and delivery is 2-3 weeks ARO. For more information contact Robert J.

Fain, Digital Power Corp., 2060 The Alameda, San Jose, CA 95126, (408) 246-4337.

CIRCLE INQUIRY NO. 229

Line Surge Suppressors

The ND 200 series of Line Surge Suppressors provide extremely fast, wide-band protection of AC-powered equipment from destructive, high-energy surges and transients.



The ND 200 Line Surge Suppressor provides an economical means of protecting valuable equipment. Protection is accomplished by virtually instantaneous absorption of excess transient energy by a state-of-the-art suppression device. A supplemental ferrite filter reduces spikes and transients which fall below the level of the suppressor.

For more information contact Novadyne Inc., 11702 Trask Ave., Garden Grove, CA 92643, (714) 636-4620.

CIRCLE INQUIRY NO. 231

P.O. Box 4430N Santa Clara, CA 95054

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8212	2.90		28.95	2112-2	3.95
8214	8.00			2114	8.50
8216	2.90			MK4116	27.50
8224	2.95			2513B	6.30
8226	3.35			21102-1	1.49
8251	9.25			MM5262	4.40
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N82S131	3.75			9368	3.50
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N82S137	8.75			2101-1	3.95
				2102-1	1.28
				2102AL-4	1.60
				21F02	1.65

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1 MHz	4.50	2.0100 MHz	1.95
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5 MHz	4.25	3.2768 MHz	4.50
10 MHz	4.25	5.0688 MHz	4.50
18 MHz	3.90	5.185 MHz	4.50
20 MHz	3.90	5.7143 MHz	4.50
32 MHz	3.90	6.5536 MHz	4.50
32768 Hz	4.00	14.31818 MHz	4.25
1.8432 MHz	4.50	18.432 MHz	4.50
3.5795 MHz	1.20	22.1184 MHz	4.50
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Video Interface board kit			125.00
16K EPROM board kit w/o PROMS			74.50
16K Static RAM board kit			395.00
North Star Floppy Disk Kit			\$665.00
Additional Drive Kit			415.00

Paratronics 100A Logic Analyzer Kit			
Model 10 Trigger Expander Kit			\$199.00
Model 150 Bus Grabber Kit			\$229.00
			\$369.00

New Cosmac Super "ELF"

RCA CMOS expandable to 64K microcomputer w/HEX keypad input and video output for graphics. Just turn on and start loading your program using the resident monitor on ROM. Pushbutton selection of all four CPU modes. LED indicators of current CPU mode and four CPU states. Single step op. for program debug. Built in pwr. supply.

4K Elf Expansion Board Kit with Cassette I/F \$79.95

Available on board options: 1K super ROM monitor \$19.95. Parallel I/O port \$7.95. RS232 I/F \$3.50. TTY 20 ma I/F \$1.95. S-100 Memory I/F \$4.50.

Tiny Basic for ANY 1802 System

Cassette \$10.00 Super Elf owners take 30% off.
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256 Bytes of RAM, audio amp. & spkr. Detailed assy. man. w/PC board & all parts fully socketed. Comp. Kit \$106.95. High address display option 8.95; Low address display option 9.95; Custom hardware cab.; drilled front panel 19.75; Nicad Battery Backup Kit w/all parts 4.95; Fully wired & tested in cabinet 151.70; 1802 software club. 10-12 pg. monthly publication 12.00 per yr.

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DC clock with 4-50" displays. Uses National MA-1012 module with alarm option. Includes light dimmer, crystal timebase PC boards. Fully regulated, comp. instructs. Add \$3.95 for beautiful dark gray case. Best value anywhere.

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CIRCLE INQUIRY NO. 91

Hi-Rel Switching DC Power Supplies

The Model SWS 750 line is rated at 750 watts. The units are available in five models, providing 5, 12, 15, 24 and 28 volts DC, from 28 to 150 amps.



These switchers are designed for the lowest possible parts count consistent with maximum reliability and performance. This improved MTBF, coupled with soft-start circuitry, significantly extends the service life.

Other features include over-temperature protection, low-input shutdown protection and full load burn-in. The SWS 750 models are priced at \$675 each and are available with 8-week delivery. For more information request new Bulletin from Standard Power, Inc., 1400 S. Village Way, Santa Ana, CA 92705, (714) 558-8512.

CIRCLE INQUIRY NO. 234

High Reliability, Patented, Switching Power Supply

The "Black Demon" series are patented A.C. to D.C. and D.C. to D.C. high frequency switching power supplies with an MTBF of 70,000 hours.



These PWM inverter type supplies employ an exclusive one switch transistor circuit. Control is achieved by a single D.C. voltage. Because of the simplicity of the power and control function, a significant increase in power density is achieved.

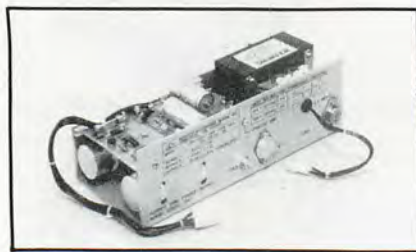
Prices range from \$338.10 in unit quantities down to \$226.95 in quantities of 10-24. For more information contact Adtech Power, Inc., 1621 S. Sinclair St., Anaheim, CA 92806, (714) 634-9211.

CIRCLE INQUIRY NO. 228

Lightweight High-Efficiency Power Supply for 2 Floppies

The AED 201 is designed specifically to provide the special DC power range required to operate floppy disk drive subsystems incorporating from one to two disk drives.

Output is +5V @ 5A, -5V @ .7A, +24V @ 2.8A. The unit has foldback current limiting on +5V, and is designed to meet UL 478.



Power is provided for drive electronics, formatter, associated interface circuitry. The unit weighs only 7.5 lbs. max. and has microprocessor capabilities.

Price is \$77 in production quantities/80¢ per watt. For more information contact Advanced Electronics Design, Inc., P.O. Box 61779, Sunnyvale, CA 94088, (408) 733-3555, ext. 16.

CIRCLE INQUIRY NO. 227

Multi-Output Microprocessor Power Supply

Designed especially for Series/80 microprocessor boards or other microprocessor systems, the BLC 635 is a new multi-level power supply that combines precise line and load regulation with current limiting, over-voltage protection and power-failure detection.



An AC power failure detection circuit supplies a TTL compatible high-level signal when line voltage drops 10 percent below normal.

The BLC 635 with cables for the Series/80 products is priced at \$460. OEM quantity discounts are available. Delivery is off the shelf. For more information contact National Semiconductor Corp., Computer Products Group, 2900 Semiconductor Dr., Santa Clara, CA 95051.

CIRCLE INQUIRY NO. 230

Triple Output Power Supply for Four Floppies

The AED 101 is a high-efficiency power supply designed specifically to provide the special DC power range required to operate floppy disk drive subsystems incorporating from one to four disk drives.



Output is +5V at 12A, -12V at .7A, +24V at 3.5A. The unit is compact in design and weighs only 10.5 lbs. max. Other features include foldback current limiting, switching regulation on +5V and UL 478 recognized.

Power is provided for drive electronics, formatter, associated interface circuitry. Price is \$137.50 in production quantities/90¢ per watt. For more information contact Advanced Electronics Design, Inc., P.O. Box 61779, Sunnyvale, CA 94088, (408) 733-3555, ext. 16.

CIRCLE INQUIRY NO. 232

Components

Wire Wrap Board

Technical Micro Systems has announced the first in a series of products designed for use with Texas Instruments TM 990/100M Microcomputer.



The TMS WWB (Wire Wrap Board) holds 63 14-20 pin ICs. Dedicated power, ground and decoupling are provided for 20-pin ICs. Connections to the 100-pin edge card fingers are via wire wrap sockets. Additional I/O is provided

via 3M connector locations at the top of the board.

Price is \$65.00. Delivery is stock. For more information contact Paul Cloud, Technical Micro Systems, 17935 Sky Park Cir., Suite K, Irvine, CA 92714, (714) 549-3991.

CIRCLE INQUIRY NO. 248

Prototype Boards for Heath H-8

Celetron has made available prototype boards for the Heath H-8 computer system in both the general purpose type for point-to-point wiring, and a wire wrap version.

The general purpose type is priced at \$29.95 and is designated as PC 1190. PC 1191 is for extreme high density applications. Priced at \$34.95, it can only be used with wire wrap sockets.

The boards come with the appropriate mounting bracket, as well as the connectors that plug into the Heath H-8 bus.

PC 1204 is an extender board for the Heath H-8 system and is available for \$24.95.

A 24x80 video board of the memory map type with its own on-board RAM and a direct inter-

face to a parallel keyboard will be available shortly.

The prototype boards and the extender board are stock. For more information contact Celetron, P.O. Box 6215, Syracuse, NY 13217, (315) 422-6666.

CIRCLE INQUIRY NO. 236

AVA Introduces New RF Video Adapter Line

AVA Electronics, manufacturer of equipment and parts for the CATV, MATV, CCTV and CB markets, announces the introduction of their new RF Video Adapter Line.

The full line will contain over forty adaptors and accessories suitable for home and professional video application. The adaptors over four series of connectors: Phono, BNC, UHF and F.

Send for the free #478 catalog sheet describing these products in detail: AVA Electronics Corp., 242 Pembroke Ave., Lansdowne, PA 19050.

CIRCLE INQUIRY NO. 238

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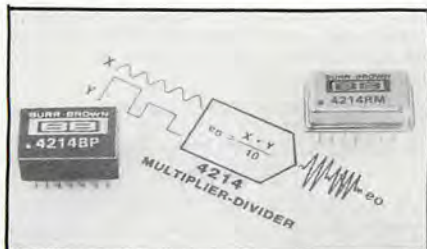
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Multiplier-Divider is in 14-Pin DIP

The new 4214 differential-input multiplier-divider offers guaranteed accuracy as low as 0.5% and a noise spec of 120uVrms (10Hz to 10kHz). Its price of \$22.50 in 100's is the lowest published price for 0.5% accurate multiplier-divider in a 14-pin DIP.



Because the unit's thin-film resistors are laser trimmed to precise values, no external components are needed to "fine tune." This fact, plus the convenience of the 14-pin package, make the 4214 a highly reliable, cost effective solution to analog multiplication problems.

Four versions are available to meet various requirements for accuracy, offset voltage, drift and temperature range. For more information contact Naresh Shah, Product Manager, Burr-Brown, International Airport Industrial Park, Tucson, AZ 85734, (602) 746-1111.

CIRCLE INQUIRY NO. 239

New Economy "Snap Fit" LED's

Model EL-41 LED's are ideally suited for high volume, low cost applications. They mount from the rear in a $\frac{3}{16}$ " (.187 \pm .02) clearance hole without mounting hardware. Their ribbed body easily snaps into panels $\frac{1}{8}$ ", $\frac{3}{16}$ " or $\frac{7}{32}$ " thick thereby providing for simple installation.



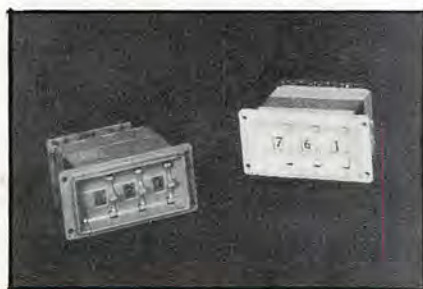
The new EL-41's feature bright red Hewlett Packard LED's and high impact butyrate plastic bodies. They are available in 5 body colors, bi-pins or leads.

EL-41 LED's are 60c each in quantity. Deliveries on small quantities within 7 days. For more information contact Ledco™ Div., Wilbrecht Electronics, 240 Plato Blvd., St. Paul, MN 55107, (612) 222-2791.

CIRCLE INQUIRY NO. 237

Voltage Divider Offered in Colors

Thumbpot, an incremental voltage divider in a thumbwheel switch assembly, is offered in white and gray.



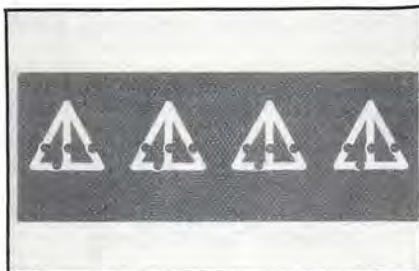
Designed to replace ten turn potentiometers, Thumbpot has the advantage of in-line digital readout, perfect resettability and rapid data entry. A wide range of options are offered, including lighting, decimal points, special marking, fast-mount hardware and gloss or matte finishes.

Standard .1 resolution (3-station) 1% accuracy, 10K ohm unit is \$18.75 in 100 piece quantity. Delivery is 6 weeks ARO. For more information contact EECO, 1601 E. Chestnut Ave., Santa Ana, CA 92701, (714) 835-6000 Switches.

CIRCLE INQUIRY NO. 241

Hexadecimal Display Digit — 64¢

The four lines of each triangular digit are binary weighted. The dark spot in each line is an LED. A lit LED indicates the respective line is active. LEDs can be driven directly from 7493 counters or equivalent devices — no dedicated drivers needed.



The advantage of the triangular digits — they are easily written. Only two require lifting the pen from the paper. It takes one day to learn to read the digits with the same facility with which conventional digits are read. A pair of digits provide convenient readout for an 8-bit word.

Restriction to decimal is no problem. Try them. If you're not satisfied, return them within 16 days and receive a full refund. Standard item is an 8-digit strip.

For more information contact CCIC, 4719 Squire Dr., Indianapolis, IN 46241.

CIRCLE INQUIRY NO. 240

Optic-Electronic Sensor

An optic-electronic sensor with built-in relay or triac output features exceptionally small size. The sensor is a highly reliable, self-contained control unit for conveyors, automatic doors, barriers on machinery, position detecting and counting.



Both the emitter and receiver of the sensor are contained in a housing measuring only 1.6" x 2.4" x .5" and weighing 7 ounces. A modulated infra-red beam from the emitter is focused, reflected back and refocused onto a phototransistor detector. This signal is amplified, demodulated and used to switch a S.P.D.T. output relay or all solid state triac. The relay is energized when the light beam is uninterrupted. Operation range is to 10 ft., and the process is unaffected by ambient light.

Write for Bulletin RT6, Gould Inc., Controls Division, R.B. Denison Operation, 103 Broadway, Bedford, OH 44146, (216) 232-8200.

CIRCLE INQUIRY NO. 244

Matrix Printhead

The UMI Mark IV OEM matrix printhead is designed specifically to satisfy the need for companies that are vertically integrating in their peripheral products. The UMI MARK IV OEM printhead is designed for heavy duty use and can be easily integrated into any new or existing printer design.



The low unit cost and the toleration to print gap variations make the printhead an ideal choice for anyone interested in filling the need for low cost high reliability printers for the booming microcomputer industry.

Delivery in OEM quantities will start in July 1978; evaluation units are available now. For more information contact Joseph Ku, Universal MicroPrinters, Inc., 1155C Chess Dr., Suite F, Foster City, CA 94404, (415) 574-8855.

CIRCLE INQUIRY NO. 249

A/D Converter Subsystem

μ A9708 is a low cost monolithic 6-channel, 8-bit converter subsystem, designed for use with MOS microprocessors like the F3870 and the F6800.

It provides 8-bit, $\pm \frac{1}{2}$ LSB conversion in 300 μ s, featuring auto zero, full-scale correction and ratiometric conversion capabilities.



The device uses the microprocessor system to provide the necessary addressing, timing and counting functions and includes a one 8 decoder, 8-channel analog multiplexer, sample and hold, output comparator on a single monolithic chip packaged in standard 16-pin plastic or ceramic DIP.

For more information contact Fairchild Camera and Instrument Corp., 313 Fairchild Dr., Mountain View, CA 94042.

CIRCLE INQUIRY NO. 235

Little Dipper™ DIP Inserter

Techni-Tool's new Little Dipper line of DIP inserters has been expanded to four models. Now available for delivery are models for 8-10, 14-16, 28 and 40 pin DIP configurations.



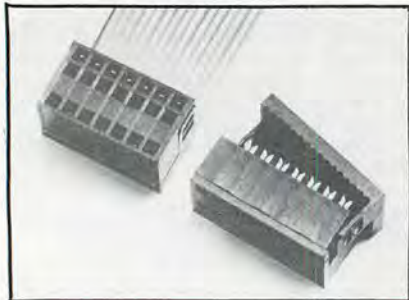
This unique line of IC inserters are the fastest manual inserters on the market. Features include rugged, non-wearing construction and self-aligning characteristics. There is adjustable center spacing for manufacturer's tolerances. No-stress insertion and static control are of interest to handlers of MOS and CMOS devices.

For more information contact Techni-Tool, Inc., Apollo Rd., Plymouth Meeting, PA 19462, (800) 523-7798.

CIRCLE INQUIRY NO. 245

Connectors Speed Ribbon-Cable Termination in Microcomputer Systems, Instrumentation

Two series of planar ("ribbon") cable connectors designed for use in microcomputer systems, minicomputers, and stand-alone logic assemblies and backpanels, as well as a wide variety of test and measurement hardware, are available from Spectra-Strip.



The first of the planar cable connectors are the 804 Series IDC DIP/Socket connectors with fixed insulation-displacing contacts for easier, more reliable mass termination at a lower installed cost.

The second of the planar cable connectors are the 805 Series IDC DIP/Plug connectors which conveniently insert into IC sockets and provide planar cable interconnection to PC boards.

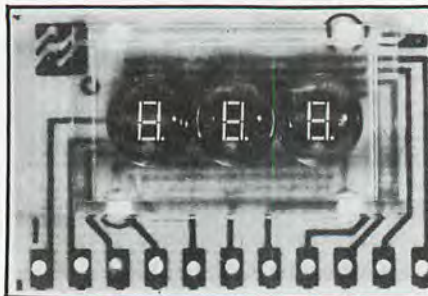
For prices and further information, contact John Stafford, Connector Product Manager, 7100 Lampson, Garden Grove, CA 92642.

CIRCLE INQUIRY NO. 246

New Cost Effective LED Display

National Semiconductor Corp. has a 3-digit monolithic GaAsP LED display which utilizes cost effective PC board mounting instead of

dual in-line molded packaging. In quantities of 100, the 0.100 inch (2.54 mm) NSA0038 is priced at \$2.20.



The Thinner PC board mounting offers substantial space savings, making the displays appropriate for timers, event counters, digital instruments, and other applications where space is at a premium.

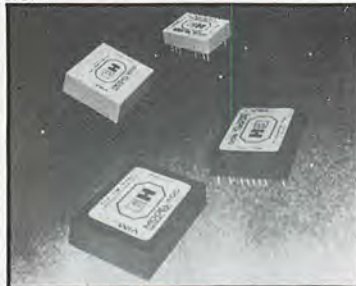
The common cathode multiplexed display has a minimum peak current of 2.5 mA per segment and a typical digit light intensity of 2.96 mcd at peak current. Delivery is from stock.

For more information contact National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, CA 95051, (408) 737-5153, Michael Fiske.

CIRCLE INQUIRY NO. 247

High-Performance Modules Simplify Test Fixturing

A line of high-performance source and measurement modules simplify building of test fixtures for complex automatic test equipment. The modules, suitable for testing integrated circuits and logic assemblies, provide standard, tested functions that previously had to be developed inhouse by test systems engineers.



The first eleven modules offered include high speed and high voltage drivers, current-to-voltage converters, comparators, and input/output switches. Two modules provide exceptional 600 picosecond risetimes for driving high speed ECL circuits.

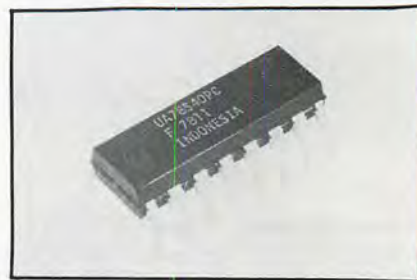
The modules are available from stock at EH distributors, or from EH International at prices ranging from \$90 for the high speed drivers to \$275 for the high speed voltage comparators.

For more information contact EH International, Bruce Brough (415) 326-6141 or John Long (415) 834-3030.

CIRCLE INQUIRY NO. 242

Universal Switching Regulator Subsystem

The uA78S40 is a Monolithic Regulator Subsystem consisting of all the active building blocks necessary for switching regulator systems. The device consists of a temperature-compensated voltage reference, a duty-cycle controllable oscillator with an active current limit circuit, an error amplifier, high-current, high-voltage output switch, a power diode and an uncommitted operational amplifier.



The device can drive external npn or pnp transistors when currents in excess of 1.5A or voltages in excess of 40V are required. The device can be used for step down, step up or inverting switching regulators as well as for series pass regulators. It features wide supply voltage range, low standby power dissipation, high efficiency and low drift. It is useful for any stand-alone, low part-count switching system and works extremely well in battery operated systems.

For more information contact Fairchild Camera and Instrument Corp., 313 Fairchild Dr., Mountain View, CA 94042, (415) 962-4903.

CIRCLE INQUIRY NO. 243

Literature

New Book Published in Addison-Wesley Series in Computer Science

If you intend to write programs in PASCAL — a widely accepted and useful language that can be efficiently implemented and is an excellent teaching tool — then *Programming In PASCAL*, by Peter Grogono, is a must.

The author states that professional programmers spend a lot of time revising programs written by themselves, or others, and if they do not fully understand these programs, their attempts at revision will eventually ruin them. Grogono stresses a point: learn how to read and modify programs equally as well as how to write them.

The programs that Grogono uses in his book are short, simple, and complete working programs; they are not trivial and may require a fair amount of work. A superficial understanding of these programs can be obtained by reading them, but the author specifies an attempt should be made to improve them.

Programming In PASCAL is a book which communicates to the reader, the essence of effective programming. It is especially suited for computer science majors' study of theoretical concepts.

Price of the book is \$9.95. For more information contact Addison-Wesley Publishing Co., Inc., Reading, MA 01867, (617) 944-3700, ext. 396, Margo LaPietro.

CIRCLE INQUIRY NO. 251

Logic Analyzer Application Literature

The employment of general purpose logic analyzers to solve microprocessor problems is the topic of a new application note from the Biomation Division of Gould, Inc.

The brochure presents a practical, problem-equipment solution approach to troubleshooting microprocessor-based systems utilizing the company's 1650-D logic analyzer, 116 display control accessory and two 10-TC probe pods.

The application note uses detailed diagrams and 'scope CRT photos to help the reader easily step through the program execution.

To obtain a copy of this application note, contact Bob Lorentzen, Applications Engineer, Digital Instruments, Gould-Biomation, 4660 Old Ironsides Dr., Santa Clara, CA 95050.

CIRCLE INQUIRY NO. 250

Application Notes on Liquid Crystal Displays offered by Beckman

New six-page application note, "Liquid Crystal Displays — Principles of Operation, Construction, and Application," is offered by Beckman Instruments, Inc. The bulletin presents practical information on LCDs and specific design details that application engineers require. Sections cover electrical characteristics, application circuits, and mounting.

Diagrams illustrate display construction and operation, response time, five driving techniques, and four mounting schemes.

The LCD Application Note is free on request from Beckman Instruments, Inc., Technical Information Section, Helipot Div., 2500 Harbor Blvd., P.O. Box 3100, Fullerton, CA 92634.

CIRCLE INQUIRY NO. 255

New Catalog from PAIA Electronics

PAIA's newest 24-page catalog lists dozens of useful and interesting kits for the musician/experimenter. Featured in the catalog are the most recent additions to the PAIA line; Digital Computer Controlled Electronic Music Synthesizers, Orchestral String Synthesizer, low cost Video Display module and Single Board Computer. Perennial favorites such as the Gnome Micro-Synthesizer and a wide variety of special effects devices are also shown.

The catalog is available without charge. For a copy or more information contact Linda Simonton, PAIA Electronics, Inc., 1020 W. Wilshire Blvd., Oklahoma City, OK 73116.

CIRCLE INQUIRY NO. 252

Boschert Offers Technical Brochure On Power Supply

A technical brochure on power supplies is now available from Boschert Inc., manufacturer of power supplies over the 25 to 400 watt output range.

The brochure describes the pros and cons of designing with switching power supplies and the features of each type. It also describes typical applications of switching power supplies in CRT systems, electromechanical systems, microprocessor-based systems, and large multiple supply systems. Also included is a description of Boschert's capabilities as a power supply manufacturer.

The brochure is available from Boschert Inc., 384 Santa Trinita Ave., Sunnyvale, CA 94086.

CIRCLE INQUIRY NO. 253

Technical Bulletin Describes Beckman Gas Discharge Displays

Four-page technical bulletin describes Model SP-451 screened-on-glass, gas discharge displays capable of messages consisting of up to 16 alphanumeric characters 0.5 inch (12.77 mm) high.

Diagrams illustrate the 55 commonly used characters, segment designations, and a typical multiplex application. Outline drawings detail the display package and edgeboard connector. Tables organize recommended operating conditions and connector/segment interconnections.

For a copy of the SP-451 bulletin contact Beckman Instruments, Inc., Information Displays Operations, 350 N. Hayden Rd., P.O. Box 3579, Scottsdale, AZ 85257.

CIRCLE INQUIRY NO. 254

Radio Shack Computer User Notes

The versatile Radio Shack TRS-80 computer will be supported by a nonprofit, no-advertising users' newsletter, publishing as often as once a month. Radio Shack Computer User Notes will serve both neophyte and experienced computerists.

Being independent of Radio Shack, the user notes will be in a position to quickly disseminate news of interest to TRS-80 owners, whether or not it is from Tandy, other vendors, or from computer users.

Users needing help with their programming or systems can question a world-wide group of TRS-80 experts. People with opinions to express now have space—and a medium—available. Those with programs, accessories, or other publications, whether commercial or another user, have free use of user notes' columns.

The editors also publish a word processing newsletter, as well as user notes for S-100 and S-50 buses. Word Processing has a series on how to convert typewriters into computer printers. The Radio Shack user notes is \$10 U.S. (\$18 U.S. overseas) for 12 issues; Word Processing is \$12.95 U.S. (\$20 U.S. overseas) for 12 issues; S-100 and S-50 publications are \$5 U.S. (\$10 U.S. overseas) for 6 issues. Checks should be payable to Bookmakers, Box 158, San Luis Rey, CA 92068.

CIRCLE INQUIRY NO. 256

New Book on Games

BASIC Computer Games: Microcomputer Edition, edited by David H. Ahl contains 102 classic computer games, every one in standard microcomputer BASIC; every one complete with large, legible listing, sample run and descriptive notes.



All the classics are in here: Super Star Trek, Football (two versions), Blackjack, Lunar Lander (three versions), Tic Tac Toe, Nim, Life and Horseace.

Guessing games, matrix games, word games, plotting games, card games, educational games — they're all here. And they'll all run on your Altair, Imsai, SWTPC, Xitan, OSI, Poly, Sol, PDP-11 or other micro or mini with extended BASIC.

Price is \$7.50 plus \$1.00 postage in U.S.A., \$2.00 foreign. Club, dealer and school discounts available. For more information contact Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960.

CIRCLE INQUIRY NO. 257

PET Computer Services

Two free PET services are available through the Microcomputer Resource Center.

1) The PET Cassette Exchange. Expand your program library easily. Exchange programs for the PET computer on cassette for free, no service charge.

2) The Ultimate PET — Resource Handbook. A continually updated listing of all hardware and software sources for the PET. Send a self-addressed stamped envelope for your free copy.

Mail your inquiries to Len Lindsay, Director, Microcomputer Resource Center, Inc., 5150 Anton Dr., Rm. 212, Madison, WI 53719.

CIRCLE INQUIRY NO. 264

American Bar Association Mail Lists Now Available

The Official Mailing List of the American Bar Association, largest confraternity of lawyers in the world, is now available for rental on a commission basis from mailing list brokers throughout the United States, as well as directly from the American Bar Association.

Great versatility in selection factors of ABA mailing lists offers the knowledgeable marketer excellent opportunities to "fine tune" his direct mail efforts. These options include: 1) date of admission to the bar; 2) date of admission to membership in the ABA; 3) age; 4) areas of legal interest, practice, specialization and expertise; and 5) geographic breakouts.

Basic rental charges for the Official Mailing List of the American Bar Association are \$35 per thousand names for Member Lists; \$25 for Non-Member Lists; and \$40 for Law Student Lists.

For a free brochure and data cards on ABA list availabilities, contact The American Bar Association, Membership Dept., Attn: Emily Ryerson, 1155 E. 60th St., Chicago, IL 60637, (312) 947-3906.

CIRCLE INQUIRY NO. 263

Microcomputer Products Catalog Available from E&L Instruments

This sixteen-page Microcomputer Products catalog contains complete descriptions and detailed specifications of the MMD-1 Mini-Micro Designer and many other microcomputer products. The 8080A based MMD-1, available in kit or fully assembled form, is part of an integrated educational and development system that includes the famous Bugbooks, and many other useful accessories.

The MMD-1 features, described in this catalog, include built-in power supplies, octal keyboard, supporting firmware, LED displays, SK-10 solderless breadboarding socket, and tutorial books. Available accessories discussed in the catalog include hexadecimal keypads, a PROM programmer, a PROM eraser, additional memory, and, D/A conversion and data transmission Outboards.

Features of standard and optional software and firmware that provide octal keyboard and hexadecimal keypad executive routines, cassette and teleprinter interfaces, and editing and debugging programs are fully described and compared in the catalog.

E&L microcomputer products include many practical accessories for users of S-100 compatible systems. Included in this catalog are an interface between the MMD-1 and S-100 compatible memory cards, a solderless breadboarding card for S-100 systems, and an adapter system that connects S-100 buses to E&L breadboarding instruments.

The E&L Microcomputer Products catalog is available free from E&L Instruments, Inc., 61 First St., Derby, CT 06418, or its representatives.

CIRCLE INQUIRY NO. 258

The First Book of KIM

A beginner's guide that will take you step-by-step through the fundamentals of writing KIM programs. Dozens of programs developed through the KIM User's Notes network illustrate the programming techniques. You'll learn while having fun with such games and puzzles as Blackjack, Chess Clock, Lunar Lander, and Ping Pong.



This book also details how to expand the KIM from the basic small-but-powerful KIM-1 system to a high-and-super-powerful machine that can be adapted to home and business uses. Diagnostic and utility programs help you build extra devices onto your KIM system, such a teletype, display, or more memory. This paper back sells for \$8.95, #5119-0.

Circle the Inquiry Number to order your 15-day examination copy, or write to Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Offer good in U.S.A. and Canada only. Price is subject to change without notice.

CIRCLE INQUIRY NO. 262

Spring 1978 Heathkit Catalog Available Free

A 104-page catalog that describes the newest in electronic kits for the do-it-yourselfer is now available from Heath Company. Kits for nearly every interest are available in Amateur Radio, High-Fidelity Components, Color Television, Test Instruments, Digital Clocks, Auto, Marine and Aircraft Accessories, Personal Computer Systems and much more.



New products in the Spring catalog include games software for the H8 Computer System, a professional-quality low-cost engine analyzer, a metal detector with adjustable discrimination, a variable speed ceiling fan that is touted as both attractive and efficient, a bi-directional wattmeter, and the HW-2036A 2-meter radio for the amateur radio enthusiast.

For a copy or more information contact Heath Company, Dept. 350-590, Benton Harbor, MI 49022.

CIRCLE INQUIRY NO. 260

New Products for the Commodore PET 2001

"Getting Started with Your PET" is a new workbook now available to PET users who are anxious to put their PET to work.

This beginner's workbook supplements the documentation provided by Commodore. It covers the fundamentals of PET BASIC and explains its characteristics, limitations, and useful features. The descriptive text is heavily laced with step-by-step, detailed exercises including the expected PET responses.

If you are already an expert on your PET, "Getting Started with Your PET" is an excellent guide for other members of your family who want to use the PET.

In addition to this beginning text, workbooks on advanced topics are available. Some of the advanced techniques covered in these workbooks include string handling, arrays and loopings; graphics, cursor control, PEEK and POKE memory; programmed cassette I/O; real time clock, linkage to assembly language subroutines, subroutine nesting.

TIS also provides software applications for the PET. These programs are available as source listings and cassettes with operating instructions, theory of operations description, and performance time and space limitations.

For more information contact Total Information Services, P.O. Box 921, Los Alamos, NM 87544.

CIRCLE INQUIRY NO. 266

New Tandy Computers 1978 Catalog

A microcomputer mail-order catalog has just been issued by Tandy Computers, division of Tandy Corporation, parent company of Radio Shack.

The 52-page, 4-color catalog details a full line of popular brand microcomputers and accessories, software packages, parts and literature currently in stock. Kits and fully assembled microcomputer systems listed in the catalog range in price from several hundred dollars to more than \$20,000.



Among the nationally known brands carried by Tandy Computers are Radio Shack's TRS-80, the IMSAI 8080, Vector 1 and 1+, Xitan, Equinox 100, PolyMorphic System 8813, and many others. In addition, the store carries a complete selection of microprocessor mainframes, peripherals, software, printed circuit accessories and discrete parts and literature.

Copies of the new Tandy Computers 1978 Catalog are available by calling toll-free (800) 433-1679, or by writing to: Tandy Computers, Dept. R7, P.O. Box 2932, Ft. Worth, TX 76101.

CIRCLE INQUIRY NO. 265

Literature Describes New Xylogics Disk Controller

Xylogics, Inc. has available new literature describing the new Phoenix 311 Mass Storage Disk Controller and Subsystems for interface with Data General Computers.



CIRCLE INQUIRY NO. 259

Providing up to 1.2 billion bytes of on-line storage, the Phoenix 311 can be connected to up to four "storage modules," or Trident generation disk drives offered by Control Data Corporation, Calcomp, Ampex, Memorex, ISS, Microdata, Okidata and other manufacturers.

Consisting of a formatter and a Nova* interface board the Phoenix 311 is packaged in an attractive 5 1/4" NEMA rack mountable chassis that is supplied complete with power supplies and self-contained cooling. The Nova* interface card plugs directly into any available standard I/O slot in the host computer.

For more information contact Xylogics, Inc., 42 Third Ave., Burlington, MA 01803, (617) 272-8140, Jean Reade.

CIRCLE INQUIRY NO. 267

How To Build A Computer-Controlled Robot

The technologies of robotics and microprocessors have been combined to form the ultimate in current hobby computer technology — a computer-controlled robot! "Mike" moves under his own control, avoiding all objects placed in his way. He will stop, start, and change direction on voice command. Soon, "Mike" will be able to see through an image-sensor camera.

This book describes how you can build your very own "Mike," controlled by a KIM-1 microprocessor. Every step of the construction of "Mike" is explained, with the complete control programs clearly written out. You may use the directions and programs exactly as they are set forth to duplicate "Mike," or as a basis for developing your own design.

This paperback sells for \$7.95, #5681-8. Circle the inquiry number to order your 15-day examination copy, or write to Hayden Book Co., Inc., 50 Essex St., Rochelle Park, NJ 07662. Offer good in U.S.A. and Canada only. Price is subject to change without notice.

CIRCLE INQUIRY NO. 261

New Wire Routing Catalog Now Available

A completely new catalog on Wire Routing Devices has been prepared by the Fastex Division of Illinois Tool Works Inc.

The catalog includes all recent innovations in routing devices, such as clip-on components that slip over a panel edge, and snap-in stand-off Purse Locks that both bundle and route wires. Over twenty basic styles of routing clips are detailed in the new catalog with all dimensions given in both inches and millimeters.

For a free copy of this informative new catalog of Routing Devices for Wires, Cables, Rods, Hoses and Condensor Supports contact Fastex, a division of Illinois Tool Works Inc., 195 Algonquin Rd., Des Plaines, IL 60016.

CIRCLE INQUIRY NO. 259

Software

FAL II

A financial analysis language able to provide financial executives and business managers with fast, easy-to-use computerized reporting capability is available from General Electric's Information Services Division.

Known as FAL II, the modeling language gives the managers the ability to establish financial applications ranging in complexity from "one-time" summary reports to forecasts, as well as what-if analysis and consolidation and budgeting for multilocation and multidivisional corporations.

FAL II applications include operational summaries, capital expenditure reports, investment and tax analysis, as well as sales reports, cash flows, inventory statements, and other financial reports.

Due to the English-like construction of the

FAL II language, users with little or no computer experience can learn to design and produce reports in a few hours. Report features include many formatting options and column and row editing options, so that users can design and redesign reports to meet changing business needs.

Other features of FAL II include the ability to perform complex calculations — such as depreciation, present value, return on investment and amortization schedules — without additional programming.

For further information on the application of FAL II or other financial and business systems available on MARK III Service, contact a local representative or write to General Electric Information Services Division, Attn: Manager of Financial Services, 401 N. Washington St., Rockville, MD 20850.

CIRCLE INQUIRY NO. 275

Legal System

Law Offices System does word processing and attorney accounting. The Xyon III legal system is geared specifically to fit the needs of law offices. It can be used as a stand alone system using the computer to create documents, schedule jobs, and do specialized accounting. Documents and information can be saved for later, using its dual diskettes or be printed out on the high quality "typewriter style" printer.

As the needs of an office grow, Xyon III expands to fit those needs and keep the costs in line. The Xyon can be expanded to use as many as 20 to 30 CRT stations. Hard disk can be added for large data storage applications, to store up to 40 million characters.

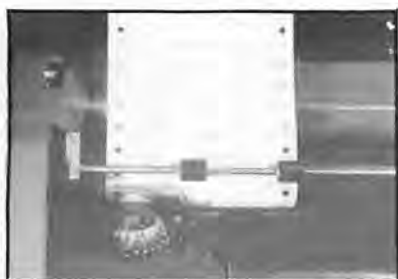
The complete modularity of the Xyon III is your guarantee of non-obsolence and ex-

tensability. For further information contact Computer Systems Unlimited, P.O. Box 870, Milpitas, CA 95035, (408) 262-6271.

CIRCLE INQUIRY NO. 271

Mail List

MAILOUT mailing list processor now includes seven modules: BUILD, SORT, LIST, UPDATE, EXTRACT, LETTER, and HELP. Sorts on zip or address/title. Merges or extracts sub-files based on codes stored with address.



Prints envelopes or labels in one or more columns. Processes letters against mailing lists. Label size is under user control. Send five dollars for users manual or \$75 for complete program. Available in Commercial BASIC or Microsoft BASIC versions. Supplied on CP/M type diskette. Dealer licenses available.

For more information contact Center for the Study of the Future, 4110 N.E. Alameda, Portland, OR 97212, (503) 282-5835.

CIRCLE INQUIRY NO. 274

Cromemco Trace System Simulator

Cromemco's TRACE is a powerful system simulator program designed to facilitate assembly language program development on Cromemco computer systems. Trace emulates the behavior of a Z-80 processor as it follows the logic of the user program.

Virtually all aspects of System Operation can be simulated, including prioritized interrupts and I/O commands. Trace options include control of register display and choice of display frequency. A historical record of program execution is maintained in a 100-instruction circular queue.

Features which help the user locate errors quickly include warnings if the user writes to unexpected areas, simulation of Input-Output commands on the console, warnings of attempts to execute undefined commands, undefined calls to CDOS routines, improper return from subroutine calls, and execution of branch instructions or decimal adjust if the relevant flags are in an undefined state.

The advanced features of Trace enable it to be used in place of logic analyzers or in-circuit emulators in program development.

Trace is available on 5" (Model TSS-S) or 8" (Model TSS-L) IBM-format, floppy diskettes for \$95. For additional information contact Cromemco, Inc., 280 Bernardo Ave., Mountain View, CA 94040; (415) 964-7400.

CIRCLE INQUIRY NO. 273

What's All This Microbiz?

A microcomputer system — computing power for use by anyone. Its possibilities stagger the imagination. But for some, computer systems have been expensive mistakes. The right things must happen in order to a computer system to profit its user.

Microbiz is a company designed to provide the small system user with the support required to make the computer a valuable tool. This support may include:

1. Consultation and design for the best solution to your application.
2. Custom software and software support. Hardware maintenance and service contracts.
4. Computer supplies.

For more information on how to be a happy

microcomputer system user, or to meet a Microbiz representative, in Southern California call (213) 423-4000, or write to Microbiz, P.O. Box 5727, Long Beach, CA 90805.

CIRCLE INQUIRY NO. 277

NCR Announces Special Packages for Hospitals, Anesthesiologists

NCR Corporation has two new sets of computer programs for the health-care industry.

The NCR Hospital Payroll system is designed for use with the company's I-8200 computer family and can process the payroll of hospitals with up to 2,000 employees.

The system handles both hourly and salaried personnel and can compute taxes for several states. Local taxes can also be calculated and withheld automatically. Up to eight automatic deductions may be used for each employee. The programs are written in COBOL and are available for immediate delivery for an initial fee of \$1,225 and a monthly fee of \$40.

The second software package meets the billing and accounts receivable processing needs of anesthesiologists. It is designed for use with the NCR 499 data processing system and can handle the requirements of from nine to 12 doctors/anesthesiologists.

All patient information, charges, payments and adjustments are entered via the 499 keyboard. The billing and service pricing data is based on the coding system published by the American Society of Anesthesiologists and a special file is maintained of the most often used ASA codes.

This system is also available for immediate customer delivery and is subject to a one-time charge of \$1,500.

For more information contact NCR Corporation, Dayton, OH 45479, (513) 449-2150.

CIRCLE INQUIRY NO. 268

Software for 6800

Inventory Software for 6800 is a program that provides a capacity of up to 1000 80-character items per disk. Contents are item search, daily activity report, minimum quantity search, list by item, list by class, list by vendor, access a different file, update a file, create a new file.

Payroll Software for 6800 program will tabulate payroll record, print paychecks, list employee records, summarize employer tax records, create new file, open a different file, and end of year or quarter records.

Billing Software for 6800 program prints mailing labels, bills, overdue and aging notices. It will furnish reports for customer A/R, sales, and last purchase. Also has file handling capabilities.

All three programs are designed to run on SWTPC CPU with Smoke Signal, SW, Percom disks or cassette. All run in 16K and are available on disk or cassette for \$200. Visa and Master Charge welcome. For more information contact Stephen Moe Co., P.O. Box 595, Springfield, OR 97477, (503) 726-p7613.

CIRCLE INQUIRY NO. 269

Data Base/Query System Responds to Pidgin English

Your home or business computer can manage a data base of stored information and respond to your queries in pidgin English, using a new microcomputer software package.

Dubbed WHATSIT — or "Wow! How'd All That Stuff Get In There!" — the system is so compact it runs in BASIC on a modest personal computer. Yet it brings the power of a Data Base Manager to the business or professional user.

Data is stored and retrieved by typing pidgin English requests such as "WHEN'S DR. JEKYLL'S APPOINTMENT?" Indexing and disk space allocation are handled automatically.

Available in North Star BASIC, the system runs in 24K of total memory. WHATSIT is offered complete with three ready-to-run programs on a minidisk, plus an extensive manual written in non-technical language.

Single quantity price is \$75.00 with trade discounts available. WHATSIT is available at local computer stores or from Information Unlimited, 698 W. 70 So. Private Rd., Hebron, IN 46341.

CIRCLE INQUIRY NO. 270

New H8 Software from Heath

Heath Company has introduced additional software for its H8 Personal Computer.

Extended Benton Harbor BASIC with file capability, is a faster, more powerful version of the BASIC software provided with the H8. It includes among other things, character strings, more convenience and math functions, dynamic storage allocation and access to a real time clock. Extended Benton Harbor BASIC requires 12K to 18K of memory and is available in audio cassette or paper tape form. Specify HC-8-13 (mail order price \$20.00) for the cassette and H8-14 (mail order price \$10.00) for the paper tape.

New games software for the H8 includes PA-82 Biorhythm, PA-83 Space War and PA-84 Game Set #1 that incorporates Craps, Orbit, Tic Tac Toe, Nim, Hexapawn, Hangman, Hmrabi and Derby. Biorhythm runs under Extended Benton Harbor BASIC and requires 16K of RAM. Space War and Game Set #1 require 24K and 8K of RAM respectively. The games are available in cassette form only and sell for \$10.00 each (mail order Benton Harbor).

For additional information contact Heath Co., Dept. 350-580, Benton Harbor, MI 49022.

CIRCLE INQUIRY NO. 276

PDS

The PDS program development system is now available, ready to run, for the North Star Horizon, or any Z80/8008/8085 computer using either the North Star minidisk or the Micropolis MOD II disk.

PDS is an exceptionally powerful system including:

MAKRO	Relocating macro assembler
ASMB	Interactive editor/assembler
EDIT	Full function text editor
DEBUG	Trace debug/disassembler
LINKED	Linkage editor
KWIK	Relocating loader

The entire package, together with over 100 pages of documentation, sells for \$99. Each of the components of PDS is fully operational on computers using the 8080 processor, yet the assemblers and single-step trace debug/disassembler feature full Z80 capability.

The capability of PDS will support the full spectrum of user experience from novice programmer to systems specialist.

The documentation includes detailed instructions on how to most effectively capitalize upon the many features of PDS, including suggestions of how one can use the conditional and macro features to develop an open-ended high-level language compiler.

No comparable assembly language development system is available anywhere. Full user support by mail or telephone will be provided.

For information contact A.M. Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107, (213) 793-5748.

CIRCLE INQUIRY NO. 272

Utilities

Rothenberg Information Systems, Inc. has two related software products — SORT and FILE INDEX, both of which have been in customer use for over one year and will operate on any size CP/M™ system.

SORT will sort any type of ASCII file in ascending or descending order. The records do not all need to be the same length. Short records will be treated as if they contain blanks in the extended areas. The keys may be as long or short as desired. The multi-key version permits up to 20 different keys. All of available memory is used for the sort. The maximum size sort that can be handled is determined as follows: The file contains N records; the keys are M characters in total length; the

system will need $N * (M + 3)$ bytes of user space. for example, to sort a file of 500 records with a key of 5 characters, requires 4,000 bytes of memory. It will take between 1 and 2 minutes to sort this size file.

FILE INDEX will read a series of diskettes placed in the B drive and write a copy of their directories onto the named file on drive A.

This file may be listed, or directly sorted with the sort program to produce a completely alphabetized list of files across all of the diskettes.

The SORT program is available in a single key version for \$95 and a multi-key version for \$145. The FILE INDEX program is available for \$45 and requires either SORT program to produce the alphabetized list. Delivery is immediate. Prepaid Orders Only. Order information should include registered CP/M serial number. For more details contact Rothenberg Information Systems, Inc., 260 Sheridan Ave., Palo Alto, CA 94306, (415) 324-8850.

CIRCLE INQUIRY NO. 281

Mini-DYNAMO

Pugh-Roberts Associates, Inc. now offers Mini-DYNAMO, a simulation package for minicomputers. Since 1960, DYNAMO, a continuous-simulation language, has been available on large computers. DYNAMO has been widely used in dynamic modeling of industrial, social, and engineering systems. DYNAMO is noted for its flexibility, ease-of-use, and excellent error detection. Mini-DYNAMO now supports DYNAMO simulation on PDP-11, NOVA, ECLIPSE, VARIAN, and other minicomputers.

Mini-DYNAMO offers standard DYNAMO equation formats, easily-specified tabular and graphical output (with automatic or user-specified scaling), automatic sorting of equations for correct computational order, ability to rerun the model without recompiling, and a variety of options to tailor output to users' needs. Mini-DYNAMO can be licensed from Pugh-Roberts Associates, Inc. The one-time license fee is \$2500 (\$100 for educational institutions).

For more information contact Pugh-Roberts Associates, Inc., 5 Lee St., Cambridge, MA 02139, (617) 846-8880, Dr. William Shaffer.

CIRCLE INQUIRY NO. 280

Business Software

Accounts Receivable can now be processed on your 8080 or Z-80 based CP/M™ microcomputer system with Structured Systems Group's General Ledger compatible Accounts Receivable system.



The software package is a full open item billing system for small businesses. The programs are designed for use by business-oriented professionals who need reliable and simple operations. The system is excellently documented with a 120-page reference manual that quickly orients the first-time user and provides depth for the experienced hand.

The A/R system, priced at \$750, features itemized statements, two aged trial balance reports, late charges, reminder letters, recurring receivables, sales reports and more. For detailed information contact Structured Systems Group, Inc., 5615 Kales Ave., Oakland, CA 94618, (415) 547-1567.

CIRCLE INQUIRY NO. 282

Powerful MTX Display Software Packages

Two powerful new software packages are now available to support the two high resolution, \$100 bus compatible alphanumeric and graphics video boards from Matrox. The first of these boards is the ALT-2480, giving a 24 line x 80 column alphanumeric display. The second is the ALT-256, a self-contained 256 x 256 high resolution graphics board. Both cards can be used either singly or in combination to configure a wide variety of intelligent display systems. Examples include an intelligent alphanumeric terminal and a color or grey scale graphics imaging system with superimposed alphanumeric. The software packages can support a wide variety of applications.

The MTX-ALPHA software package is designed for use with the ALT-2480 and provides the user with all the capabilities of an intelligent terminal. The package has been designed explicitly to permit easy and reliable modification to meet varying user requirements. MTX-ALPHA will fully emulate the popular Lear Siegler Inc. ADM-3A and Digital Equipment Corporation DECSCOPE VT-52 interactive display terminals. In addition, line at a time and text block input modes are available to provide the powerful text editing features of an intelligent terminal.

The MTX-GRAPH software package is designed for use with the ALT-256 graphics display. The package is configured as a series of callable subroutines and occupies a 1K block of memory. Some features included in MTX-GRAPH are point plot and line vector graphics, variable size alphanumeric character generation, animation synchronization, and an option for color graphics.

For more information contact Matrox Electronic Systems, P.O. Box 56, Ahuntsic Stn., Montreal, Quebec H3L 3N5.

CIRCLE INQUIRY NO. 278

Microsoft Announces COBOL-80

COBOL-80 is the first COBOL for 8080/Z-80/8085 microprocessor systems. Packed with features, yet conservative with memory space, COBOL-80 is the language many microcomputer users have been waiting for.

COBOL-80 conforms to the 1974 ANSI standard, thus giving users immediate access to programs already written in COBOL. All Level 1 features and the most useful Level 2 options for the "Nucleus" and for Sequential, Relative and Indexed file handling facilities are included.

Additionally, Level 1 Table Handling, Library and Inter-Program Communication facilities are provided. Of the advanced Level 2 features, Microsoft has included the verbs STRING, UNSTRING, COMPUTE, SEARCH and PERFORM (varying/until), along with convenient specification by way of condition-names, compound conditions and abbreviated conditions. COBOL-80 allows a packed decimal data representation to conserve memory on floppy disks.

For more information contact Microsoft, 300 San Mateo N.E., Suite 819, Albuquerque, NM 87108, (505) 262-1486.

CIRCLE INQUIRY NO. 279

6502 Assembler for PET

The 6502 Assembler in BASIC is designed to run on an 8K Commodore PET. It accepts all standard 6502 instruction mnemonics, pseudos and addressing modes, and evaluates binary, octal, hex, decimal, and character constants, symbols and expressions. Source statements can be read from cassette or from DATA lists, and machine code can be assembled anywhere in memory or directed to an external device through a user-supplied subroutine.

The package includes a text editor in BASIC, and an execution monitor with a disassembler. Price with documentation is \$24.95 by check or Visa/MC from Personal Software, P.O. Box 136-17, Cambridge, MA 02138, (617) 783-0694.

CIRCLE INQUIRY NO. 286

AVID

AVID is a comprehensive state-of-the-art system for Computer Assisted Instruction (CAI) which executes on any Digital Equipment Corporation PDP-11 computer including the LSI-11 microprocessor.

In addition to the standard facilities for response-contingent presentation of textual and graphics information found in existing CAI systems, AVID includes natural language processing capabilities which permit a student to ask questions in colloquial English in order to direct the system to that lesson or portion of a lesson most germane to his question.

AVID also contains automatic programming mechanisms which permit neophyte lesson authors in a system-driven interactive dialog with the system. Also included are facilities for student record management and for the controlled administration of examinations.

The system supports up to eight simultaneous independent users and will operate on single or multiple disk systems with or without magnetic tape and hard-copy printers.

Single-user complete systems including a graphics CRT begin at \$12,000 and complete four-user systems begin at \$24,000. For more information contact Advanced Interactive Systems, 8216 Pickering St., Philadelphia, PA 19150.

CIRCLE INQUIRY NO. 283

Super BASICs

Computerware Software Services has available a new generation of BASICs for the 6800 computer. They include Cassette File handling BASIC in PROM (C000-DFFF) or on Cassette (0000-1FFF); Disk File Handling BASIC including Random Access for the SSB BFD-68 and Sequential File Access for both BFD-68 and MF-68 disk systems.

These BASIC's are fully extended in their capabilities, faster than 6800 BASIC interpreters from other sources, yet completely compatible with your existing source programs.

CSS Super BASICs have been designed to work with MIKBUG, RT-68, SWTBUG, and SMARTBUG without any modification on the disk versions and by setting the 'BUG BYTE' on the Prom and Cassette versions.

For more information contact Computerware Software Services, 830 First St., Encinitas, CA 92024.

CIRCLE INQUIRY NO. 284

Software Packaged in North Star Format

The following Applications Software on mini-diskette is packaged in North Star format. Made available through MicroAge, each of these disks is ready to run in any S-100 8080/Z80 computer system.

- Financial Programs from "Some Common BASIC Programs" by Osborne & Associates
- Mathematical Analysis Programs from "Some Common BASIC Programs"
- Statistical Programs and Miscellaneous Programs from "Some Common BASIC Programs"
- Games, Volume 1
 - includes: Trap, Batnum, Hukle, Faxman, Stars, Mathdrill I, Cannon, Chomp, Week-day, Calendar, Pony.
- Games, Volume 2
 - includes: Button, Frog, String, Change, Civil-war, Golf, Golfhand, Chase!, Shooting Star, Lunar Lander, Mathdrill II.
- Backorder Program using disk data files.
- Mailing List using disk data files

Price is \$35 each. Available from MicroAge Mail Order, 803 N. Scottsdale Rd., Tempe, AZ 85281. Interested persons can see the MicroAge Software at the Byte Shops in Tempe, Phoenix, and Tucson, Arizona, and Dallas Texas. For more information contact MicroAge, 1425 W. 12th Pl., #101, Tempe, AZ 85281.

CIRCLE INQUIRY NO. 285

Miscellaneous

Computer Tape Load Reliability Test

Loading computer tape with self-threading tape drives is difficult, or impossible, if sufficient air pressure is not supplied to position the tape for threading.



To determine if insufficient air pressure is causing load checks, 3M Company has designed a quick and efficient means of testing the air pressure delivered to the cartridge.

A loading pressure test kit is now available from 3M which includes an air pressure gauge, a modified self-threading tape cartridge and a tape reel. When the 3M brand Loading Pressure Test Kit is mounted on a drive and the self-threading function switched ON, the gauge will indicate the amount of air pressure present. If sufficient pressure is not present, appropriate action should be taken.

The kit is priced at \$100. Delivery time is approximately 60 days. For more information contact 3M Company, Dept. DR8-3, P.O. Box 33600, St. Paul, MN 55133.

CIRCLE INQUIRY NO. 290

Realistic PRO-2001 Programmable Scanner

Radio Shack's new Realistic PRO-2001 scanning monitor receiver features digital entry programming for up to 16,560 frequencies, with no crystals to buy.

The PRO-2001 uses the latest in microprocessor technology to scan 16 programmed channels or to search an entire band segment for signals. A digital keyboard, much like a pushbutton telephone's, is used to enter frequencies.



The PRO-2001 has a built-in speaker and jacks are provided for headphone, tape recorder and external speaker. Separate antenna inputs for VHF and UHF. Operates on 120 VAC or 12 VDC, negative ground. Price is \$399.95. For more information contact Radio Shack, 1400 One Tandy Center, Ft. Worth, TX 76102.

CIRCLE INQUIRY NO. 291

New IEEE-Standard 488-1975 Bus Interface for Unibus PDP-11s

A new bus interface conforming to the IEEE Standard 488-1975 Instrumentation Bus, extends the interconnection of instruments to PDP-11 computers with Unibus™ architecture.

Called the IB-11, it was developed by Digital Equipment Corporation's Laboratory Data Products (LDP) Group.

The new bus interface complements Digital's previously announced IBV11-A, designed for the low-end PDP-11/03. Digital's IB-11 permits as many as 15 instruments to be connected to PDP-11s from the PDP-11/04 through the PDP-11/70.

The new instrument bus interface is field-installable, and can be integrated into Digital's standard laboratory systems, such as the DECLAB 11/34 and DECLAB 11/60.

For more information contact Digital Equipment Corp., Maynard, MA 01754, (617) 481-9511, ext. 6973, David Simler.

CIRCLE INQUIRY NO. 298

Data Monitor

The Sanyo Model VM-4209 Data Display Monitor is an economical, high performance 9-inch (diag.) monitor designed for use in video and data display systems.



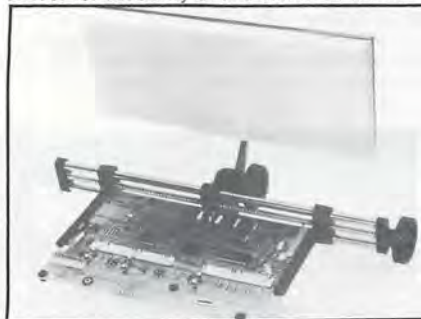
The unit features a 40 sq. in. viewing screen; convenient up-front controls; high contrast, high resolution character display; video loop-through connectors with switchable 75 ohm termination; rugged steel cabinet. Video input is 1.0 volt p-p composite. Dimensions are 8 1/2" W x 9 1/2" H x 9 3/4" D. Weight is 13.8 lbs. Power is 117 VAC, 60 Hz, 25 W.

For more details contact Sanyo Electric, Inc., 1200 W. Artesia Blvd., Compton, CA 90220.

CIRCLE INQUIRY NO. 299

Four New PCB Holders with Conductive Foam Pad

Designated PCS1 through PCS4, these PCB holders feature ease of operator use. The PCBs rest at a 30 degree angle. Units come with divider for assembly of two boards at a time.



Conductive foam pad simply rests on top of the components while total frame is flipped over and rotated 180 degrees for hand soldering.

Sizes range from 5.5" deep x 10" wide to 7.5" deep x 14" wide. Prices are from \$75.00 to \$102.00 for single quantities and are available from stock at the factory.

For more information contact Micro Electronic Systems Inc., 8 Kevin Dr., Danbury, CT 06810, (203) 746-2525.

CIRCLE INQUIRY NO. 296

Microcomputer Configuration Guide

A new microcomputer system configuration guide allows users to take a building block approach to the design of control and data collection systems.



Based on the Wyle line of prewired microcomputer rack, drawer, and cabinet configurations, the user can select the required complement of modules for a specific task.

Available are serial and parallel digital I/O, analog I/O, communications modules, and a wide variety of others including over 200 digital logic modules.

For a free copy of the configuration guide, contact Wyle Laboratories/Computer Products, 3200 Magruder Blvd., Hampton, VA 23666, (804) 838-0122.

CIRCLE INQUIRY NO. 289

Line Cord Filter/Surge Suppressor

Unexplained glitches, errors or printouts? Hash and surges on your AC power line could be the culprit. Electronic Specialists offer a convenient line cord Hash Filter/Surge Suppressor to tame hash or surge interference and glitches.



Differential or common mode Surge Suppressors will suppress the industry standard 9x20usec, 1000 amp surge. Suppression is effective against lightning or machine induced surges.

Priced at \$20.95, this 3-prong unit (Model S/F-KW-3) combines Surge Suppression and Hash Filtering in a convenient package, providing 1000 watt load protection. Other models available. For more details contact Electronic Specialists, Inc., Box 122-IF, Natick, MA 01760.

CIRCLE INQUIRY NO. 297

Micropolis-CP/M™ System Upgrade

The Micropolis-CP/M System Upgrade gives the Micropolis disk owner the full capacities of the CP/M disk operating system, while retaining full access to Micropolis' operating system.

The Micropolis-CP/M System Upgrade allows the Micropolis disk owner to participate in this standard, by acquiring a superior disk operating system with the following features:

- Directly load and start CP/M
- Automatically execute the program of your choice at system start-up
- Dynamic disk space allocation and reclamation: No more waiting for the disk to pack!

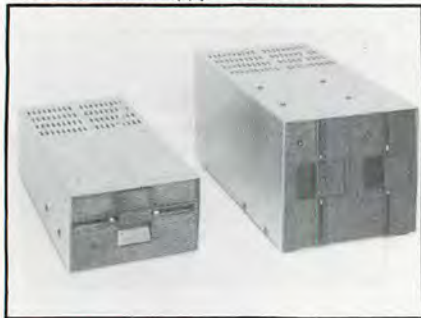
- Random access on all files
- High speed disk read and write
- Full compatibility with all other CP/M systems and software

For more details contact the Computer Mart of New Jersey, 501 Rte. 27, Iselin, NJ 08830, (201) 283-0600. Dealer inquiries invited.

CIRCLE INQUIRY NO. 300

Precision Steel Cases

Micro Technology Consultants has available precision steel cases for Shugart, Wangco, and Pertec mini-floppy disk drives.

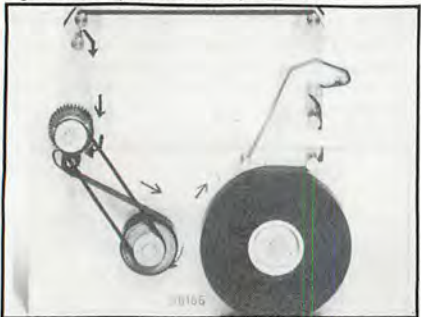


Cases are available in single and dual configurations, with a dual power supply to be offered soon. MTC cases are available through your local computer store. For more information contact Micro Technology Consultants, P.O. Box 660331, Miami, FL 33166.

CIRCLE INQUIRY NO. 295

Dual Pass Reloadable Multistrike Carbon Ribbon Cartridge

A new reloadable cartridge system, used with Qume and IBM Daisywheel printers, is being offered by Printcraft Systems, Inc.



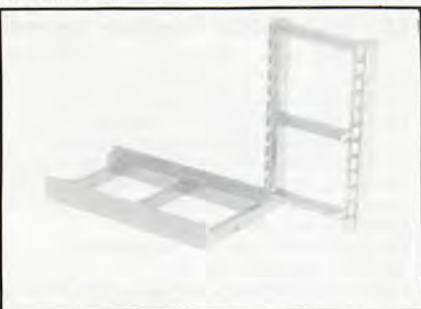
It is a removable cartridge, with an original 300-foot supply of high quality multistrike carbon ribbon. It has the unique capability of being "flipped" over for a second pass of unused carbon area, for an equivalent effective total of 600 feet of ribbon per roll. Ribbons are available in black and in colors.

Savings realized are said to be 30-65 percent. For more information contact Printcraft Systems, Inc., 11-17 Beach St., New York, NY 10012, (212) 966-0001, Don Hubbinett.

CIRCLE INQUIRY NO. 292

SAE Expands Low-Cost 3600 Series IC Socket Line

The latest additions to the 3600 series are the 18-position and 20-position sockets. The series also has sockets with 14, 16, 22, 24, and 40 contacts.



The low-profile sockets are only .150 in. (3.8 mm) high above the circuit board and maintain their .100 in. (2.5 mm) contact centers when butted end to end, providing continuous rows of contacts for universal applications and high-density packaging.

Pricing of the low-profile IC sockets is as low as \$0.006 per line with delivery in 8 weeks ARO. For more information contact Tim McGarvey at Stanford Applied Engineering, 340 Martin Ave., Santa Clara, CA 95050, (408) 243-9200.

CIRCLE INQUIRY NO. 287

Business Forms

All-Type Business Forms has some exciting news for the owners of micro/mini printers and word processing units!

All-Type Business Forms can affix a company's letterhead or envelopes onto a continuous carrier strip. This can be used on regular typewriters, slave driven typewriters, or computer printers. The customer can furnish their own letterhead and envelopes or All-Type can handle the entire job.



All-Type Business Forms can also provide stock and custom continuous labels. They can provide continuous rolodex cards that can be used to set up hard copy customer files. All-Type Business Forms can also provide continuous mailers. This is the type of form that already has the outgoing copies in an envelope. This type form can also be constructed with a return envelope.

For more information contact All-Type Business Forms, 6910 Oslo Cir., Suite 101, Buena Park, CA 90621, (714) 521-3210, (213) 926-5734.

CIRCLE INQUIRY NO. 301

Intelligent Keyboard Has Capacitive Switches

This solid state keyboard uses second generation microprocessor and patented low-profile capacitive keyswitches.

The keyboard uses an 8-bit, single chip microprocessor with on-chip ROM, RAM and erasable, reprogrammable EPROM.



All key functions are software controllable. The microprocessor permits automatic repeats, multiple application programs in a single intelligent encoder, field program

changes using new firmware, serial and/or parallel I/O, and N-key rollover (3-key rollover being standard). Options are unlimited.

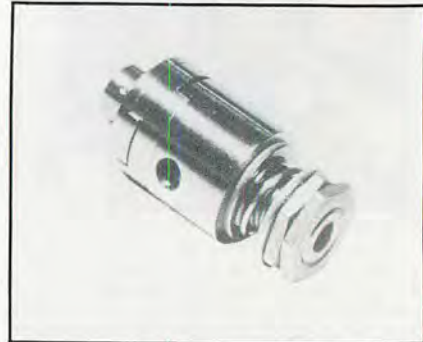
For more information contact C.P. Clare & Co., 3101 W. Pratt Ave., Chicago, IL 60645, (312) 262-7700.

CIRCLE INQUIRY NO. 288

Metric Slip Coupling

PIC Design Corporation introduces a metric line of stainless steel adjustable slip couplings.

The coupling is designed to intermittently "slow-down" a rotating component if it exceeds its torque limitations in a system.



It incorporates an internal cork slip clutch face and by slipping, eliminates damage to other expensive components. The coupling also compensates for shaft and angular misalignment and is adjustable to 0, 07 N-m torque.

Precise and dependable, the coupling is provided in shaft sizes from 3 to 3 mm up to 6 to 6 mm; backlash 0°; shaft to shaft misalignment 0,25 mm; angular misalignment 1°; max. RPM 2500 and choice of pin or split hub configuration. Prices from \$45.75.

For more information contact PIC Design Corp., P.O. Box 335, Benrus Center, Ridgefield, CT 06877, Attn: Catalog Dept.

CIRCLE INQUIRY NO. 293

PCO-1A Process Control Output Module

Now available from Wyle Laboratories/Computer Products is the PCO-1A process control output module. The PCO-1A provides two complete 4-20mA or 10-50mA process control output circuits on one Wyle microcomputer system output module. The 4-20 or 10-50 range is independently selectable for each circuit, and both outputs are short circuit protected. The PCO-1A is priced at \$345 per module (2 output circuits).



Also available from Wyle is a complete line of microcomputer and I/O modules for industrial control and data collection including 4-20mA input, optically isolated I/O, A/D and D/A converters, electronic switches, relays and more. For more information contact Wyle Laboratories/Computer Products, 3200 Magruder Blvd., Hampton, VA 23666, (804) 838-0122.

CIRCLE INQUIRY NO. 294

BOOK REVIEWS

THE Z-80 MICRO-COMPUTER HANDBOOK

By William Barden, Jr.
SAMS. \$8.95

Review by Dave Buckhout

It was a windy day in the desert and instead of getting dirty right after taking a shower, I decided to expand my knowledge in the microcomputer field. I picked up a book entitled *The Z-80 Microcomputer Handbook* by William Barden, Jr. I have been interested in the Z-80 because of its capabilities and low price for a hobbyist microcomputer.

I have considered the Z-80 as the top of the line in the Intel 8080-based CPU microprocessor field. This book reinforced my opinions, giving a good description of what the Z-80 really can do. Previously, I had only slight information on the Z-80, although I have worked fairly extensively with the Altair 8800 which uses the 8080.

The Z-80 Microcomputer Handbook has the basics for the electronics-minded as well as for those who are software oriented. I have only slight experience with hardware aspects of any microcomputer, thus it was a bit difficult to read through and understand the electronics sections in particular. I think that it takes some experience with LSI chip architecture to really comprehend the capabilities of the Z-80 as explained in this book.

But for those who lean toward the electronics aspects of the Z-80, it seems that all pertinent information is included. Examples are the pin configurations, timing diagrams, interfaces and capabilities of the Z-80. These are basically specifications and I have no reason to doubt their accuracy.

For those interested in the software capabilities, the book goes into great detail. Every instruction group is explained thoroughly. The new instructions interested me the most, especially the block move, 16-bit operations, the auxiliary registers, and the extra interrupt instructions. These instructions were well explained with examples such as a four-instruction routine to search 64 bytes for a certain character.

In general, the software section gives proof of the increased power of the Z-80 over the Intel 8080A. Ex-

plicit examples are given throughout this section and even important ways of performing certain necessities in programming for a Z-80 microcomputer are supplied.

In summary, *The Z-80 Microcomputer Handbook* is very informative and well laid out. It is a good source, whether for new information or for reference when programming or hardware upgrading your Z-80 microcomputer.

FINANCIAL ANALYSIS & BUSINESS DECISIONS ON THE POCKET CALCULATOR

By Jon M. Smith
Wiley-Interscience. \$14.95

Review by John D. Hirsch

Concentrating on the essential concepts of business-related calculations, Smith shows how compound interest/annuity formulas can be manipulated to yield answers to 12 basic types of financial problem, and explains how the confusing nomenclature in various fields can be related to these basic formulas.

Further chapters cover consumer finance, merchandising, and real estate calculations in considerable detail with casebook examples. Programmable calculators are relegated to a single perfunctory chapter drawn largely from a previous Smith book, *Scientific Analysis on the Pocket Calculator*, but manual keystroke routines are given for financial calculators and the features of various models are adequately covered.

Unlike the many business math books which teach the rote use of tables, Smith's book gives formulas on which calculator or computer programs can be based. (An exception is the section on computing days between dates, where the author reprints a table rather than discussing the interesting calendar algorithms that have been developed.)

Most of the book is written from the standpoint of the financial analyst, and Smith offers many cogent ideas based upon practical experience. His weaknesses are in the areas of securities analysis (not covered) and statistics (the chapter on statistics is a summary of introductory material without approximation formulas needed for programming probability functions).

Hopefully the few shortcomings of this book will be remedied in

future editions. It's a book that deserves to be around for a while.

PROGRAMMABLE CALCULATORS

By Charles J. and Roger J. Sippl
Matrix Publishers. \$14.95

Review by John D. Hirsch

Charles Sippl seems to be emerging as the Irving Wallace of the microcomputer/calculator field. He is raising his own family of co-authors and the Sippl clan are busily at work compiling information from a wide variety of sources and disgorging it in a series of massive, only partially-digested chunks.

The latest production repeats some material from Sippl's *Microcomputer Dictionary and Guide* and *Calculator Users Guide and Dictionary*, but includes much information on the new programmable calculators. The source for the majority of this book's content was manufacturer-supplied literature. Without regard to the title of the book, the Sippls include information on novelty calculators, microcomputers, computer peripherals, calculators in education, calculators for the blind, and a host of other topics that have apparently been languishing in the family files, waiting to see the light of publication.

This bewildering succession of topics is tied together by wordy chapter headings ("Programmability — the capabilities and techniques are primary to efficient calculator use") and transitional sections written in the Gothic style. An example of a typical sentence: "The recommended simultaneous use of the *Calculator Users Guide and Dictionary* with this book then will afford the reader the considerably more intellectual penetration of the diverse and challenging segments of utilization and future system projections of these devices," p. 68.

As a survey book on programmable calculators (including the expensive, business-oriented models), this book does contain all the information a prospective buyer would need. Definitions, formulas, photos, and elementary programming examples are scattered throughout the text, and a few excellent articles are reprinted from the HP-65 User's Club newsletter. It's a good book for browsers and a bargain by weight, if not by content. □

"A Usable Data Base" . . . What, Why, and How to Use It!

By William Turner, Southeastern Regional Editor

PURPOSE OF FILES IN DATA PROCESSING

The framework of a data processing system is its data files or data bases. Virtually all data processed by a computer is held on a file at some time or other. It is through the proper planning, control and use of files that a computer system can function efficiently. The term *file* as used in data processing has a more precise meaning than it does in manual systems.

What are the main purposes of data processing files?

- To hold data in a form that enables it to be processed rapidly by the computer.
- To make every record accessible to the computer, either individually or en total.
- To obtain security and compactness for the data.

All of these purposes are achievable, provided suitable hardware is made available for the system, and its files are used in a well-planned manner.

We can summarize everything that has to be done to a file as one of the following:

- a) Establish the file.
- b) Retrieving information from a file for some purpose; e.g. making up a report, retrieving selected records, or retrieving every record.
- c) Adding records or deleting records to a file.
- d) Making changes to records in the file.

All the problems in data processing will be concerned with one, or more than one, of these general functions.

A programmer might not care what physical form the data is in (e.g. whether an employee's pay record is in the form of a handwritten sheet, punches on a card, bits on a tape, or bits on a disk), but a data processing system can accept data only in certain forms.

A field is a particular data item, i.e. an employee number, a page reference, or possibly the title of an article.

A group of associated fields make up a record.

A group of associated records is called a file.

FIXED AND VARIABLE LENGTH RECORDS

The records in a given file are usually the same type, i.e. they each contain the same number of fields, and each field is the same size as the corresponding field in any other record. These are known as *fixed length* records. There is, however, another form of record known as a *variable length* record.

The more common use of a *variable length* record is when it is more convenient to use records that consist of a variable number of fields.

Assume, for instance, that you were designing a system that required knowing when a shipment of merchandise was received and what you paid for it. It might be more convenient to create a single record that contains just the item description, along with a pair of fields that is added on for each new shipment, containing the data received and price paid. As you would normally receive certain items more frequently than others, some of the

records in your *received* file would be longer than others. The only other choice would be to create a *fixed length* file, each record containing the item description, date received, and price paid for each shipment. In this case, the item description is repeated in each record, unfortunately requiring additional file storage space.

Another cause of *variable length* records is that they contain variable length fields. The most common example of these are in name and address files. For example, the varying lengths of names and addresses (street, city and state) can result in records that would vary from as little as 25 up to 125 characters per address. If the data is stored in a variable length format, it is necessary to somehow identify the start and end of the name, street, city and state fields so that your computer system can split them up for printing in the more normal 4 to 6 line address format.

There are two standard methods used to determine the length of a field or record: The first of the two standard techniques is to use a record length field. Generally this is a count of the total number of characters contained in that record. The length field is normally calculated and inserted by the computer when the record was first created, and is updated whenever the record is changed. The record length is usually the first field in the record but it could be placed anywhere in the *fixed length* portion of the record.

The second technique is to make use of a special symbol, or group of digits or characters that do not occur elsewhere in the record to mark or *flag* the end of the record. This end of record flag or (EOR) marker is usually positioned immediately after the final field in a record.

Obviously, there must be some tradeoffs to consider when designing a file, and trying to choose between a *variable length* and a *fixed length* format.

A *fixed length* file is usually easier to process, because you know that the customer's name is always between columns 41 and 61. The disadvantage to a *fixed length* file is that all fields must be made the same length, and that length must be large enough to contain the longest piece of data. A *fixed length* file may be easier to process, but is relatively inefficient in terms of file storage space.

A *variable length* file, on the other hand, may be relatively slower to process in some instances, but generally requires less file space to store the data.

The only way that I know how to process *variable length* data in BASIC is to treat the data record as a single character string. Even then some BASIC's will not allow you to store the data on the file as a *variable length* record. There is, however, no restriction regarding the use of *variable length* fields, within the confines of a *fixed length* record.

You must, however, read each data record as a single character string. This means that you must disassemble the record into its component parts. Normally the MID\$ or equivalent function would be used as the method to separate the fields into separate variables for processing. Fields containing strings would, of course, be moved to separate, individual string variables for further pro-

cessing. Fields containing numerical data must be converted to a numeric format through the use of the VAL or equivalent function prior to its being used as part of a numeric calculation.

One difficulty that still remains is that some versions of BASIC are horribly slow when trying to scan a character string for an "EOR" character. Their FOR-NEXT and MID\$ mechanisms are extremely inefficient! If this is the case with your BASIC, you would do better by using *fixed field length*, rather than the *end of field character* concept.

As you may have gathered by now, there is no difference between handling *variable length records* or *variable length fields*, as long as the *end of field marker* is different from the *end of record marker*. It is also possible to use a *start of field marker*, rather than an *end of field marker*, to separate one field from another.

A USABLE DATA BASE

The data base supplied on the reverse side of the May Floppy ROM* exhibits two unique attributes. The first being that it is in the IAPS* format to make it portable software, as was discussed in the May issue. The second attribute is the structuring of the files to make the data base usable.

Before discussing the actual structure of the May data base, it is important to point out that it is made to be flexible. The base can be used to either continue the index to INTERFACE AGE, or other magazines, or slightly restructured to provide a base for other information such as the best ski resorts in a given area.

THE DATA BASE STRUCTURE

Figure 1 is an overview of the two types of records found in the May data base. Figure 1b is made up of the following descriptors to define the Publication header record:

Note 1: The ASCII 'FS' — file separator — (HEX 1C), identifies the record as a publication header record.

Note 2: This is a required field and contains the name of the publication.

Note 3: The ASCII 'RS' — record separator - (HEX 1E) is used as a file separator and identifies the end of one field and the start of the next. The character immediately following the 'RS' will identify the next field. (See Notes 4 and 8 for optional field description.)

Note 4: The ASCII 'D' (HEX 44), identifies the following data as the publication date. The ASCII 'R' (HEX 52) identifies the data following it as the volume reference ID.

The following format was used for the volume and issue ID: (1-6 means Volume 1, Issue 6).

Note 5: The ASCII 'E' (HEX 45) identifies the end of a record.

Figure 1b is the article descriptor record and is made up of the following:

Note 6: The ASCII 'GS' — group separator — (HEX 1D) identifies the record as an article descriptor record.

Note 7: Page or reference number. This is used to identify where in the publication a referenced article can be found.

OPTIONAL FIELDS

Note 8: The ASCII 'A' (HEX 41) identifies the next group of data as the author's name, and is structured as shown in Figure 2.

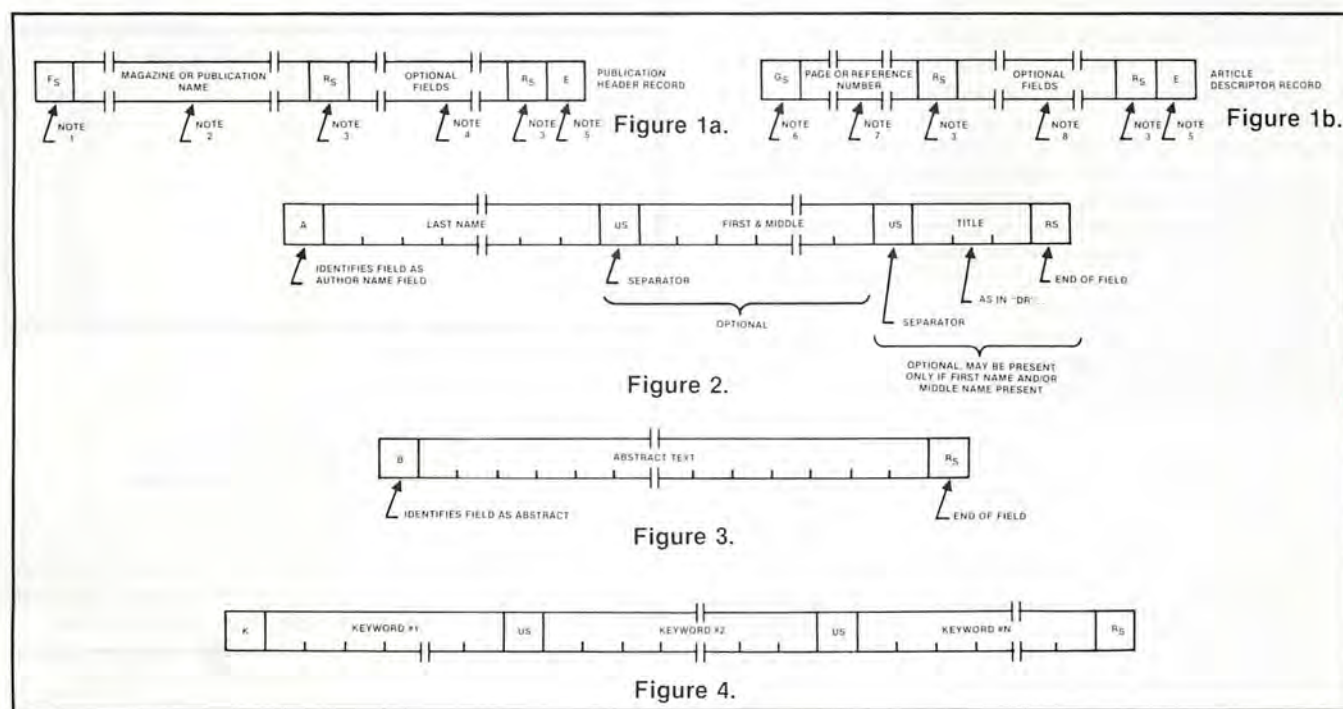
The ASCII 'B' (HEX 42) identifies the data that follows as an abstract of the article and is structured as shown in Figure 3.

The ASCII 'D' character (HEX 44) is the data indicator for publication date and is used if the magazine or book date is different from the article date.

The ASCII 'K' (HEX 4B), is a keyword indicator for use when implementing an information retrieval system, and is shown in Figure 4.

Finally the ASCII 'T' (HEX 54), identifies the data following as the title of the article and is structured the same as the abstract in Figure 3.

Next month each record format and individual field will be described. □



CP/M: An 8080 Disk Operating System With Editor, Assembler, and Debugger

Reviewed by Alan R. Miller, Contributing Editor

This article describes the features of a marvelous disk operating system called CP/M. The combination of CP/M and an 8080 or Z-80 microprocessor produces a system that approaches the versatility of large computers. I have not written this article to be an operating manual, but rather to be a complement to the extensive documentation that accompanies CP/M. In particular, I will try to help you avoid the frustrating errors I made at the beginning. Part of the problem is that there is so much to learn and there is so much information in the manuals. I hope that this article will smooth the way for you. If you still have a problem, you might contact the people either at Digital Research or Lifeboat Associates. I have found both to be very helpful. If all else fails, contact me and I'll try to help.

INTRODUCTION

Every computer needs a system monitor which, at the very least, will coordinate communication between the computer and the peripherals (keyboard, printer, video screen, tape recorder, floppy disks, etc.). This monitor should be able to perform such housekeeping tasks as displaying memory in hexadecimal and ASCII, moving a block of memory, filling memory with a constant, comparing one block of memory to another, and the ability to jump to another program in memory.

Over the past several years, INTERFACE AGE has published articles addressed to one or another of these tasks. By combining the ideas in these articles, it is possible to produce a decent, non-disk monitor. If you have a floppy disk, you need something more.

Floppy disks usually come with a minimal disk operating system (DOS) that will perform only a few of these tasks. For example, the jump command is the only non-disk operation available in the North Star DOS. The PerSci intelligent controller has only disk-oriented commands. The user, therefore, will have to write the necessary non-disk monitor commands and integrate them into the DOS. This task will be much easier if you have an assembler available. You will also want an editor to change the assembler file, and maybe even a debugger to find the problem in the resulting machine code when it doesn't do what you expected.

The people at Digital Research¹ have nicely combined just about all of the features that you could possibly want into an 8080 disk operating system called CP/M. The basic system is available on an 8-inch soft-sectored floppy diskette for \$100. The price includes a comprehensive set of operating manuals. A version of CP/M is also available for the North Star 5-inch floppy from Lifeboat Associates² for \$145.

The basic system includes a monitor, text editor, assembler, and debugger. A minimum of 16K bytes of memory (20K for the Lifeboat version) are required. Additional programs are available separately: MAC, a more powerful assembler with macro capabilities; SID, a more powerful debugger; FORTRAN, and three versions of BASIC. The prices for these additional programs, which will be discussed near the end of this article are given in Table 1.

Table 1. The cost of CP/M programs.

Program	8" Disk	5" Disk
CP/M	\$100	\$145
MAC	90	100
SID	75	85
BASIC-E	32	30
CBASIC	100	95
BASIC (Microsoft)	300	300
FORTAN	400	400

THE CP/M MONITOR

CP/M can be divided into several subsystems:

- BIOS — The basic I/O (except disk)
- BDOS — The basic disk operating system
- CCP — The console command processor
- TPA — The transient program area (user programs)

BIOS is the program that interfaces your non-disk peripherals to CP/M. Your first task is to write your own customized version of BIOS and copy it onto the CP/M diskette. This will be discussed in detail in a later section.

¹Digital Research, P.O. Box 579, Pacific Grove, CA 93950.

²Lifeboat Associates, 164 West 83rd St., New York, NY 10024.

The BDOS section takes care of all disk operations for up to four floppy disks. It maintains the file directories and the allocation of sectors. Floppy diskettes are divided into a number of concentric tracks, and each track is further divided into a number of sectors. All but the smallest programs require more than one sector. An operating system that stored data on contiguous sectors would be very inefficient. This is because the overhead in switching from one sector to the next causes the system to just miss the next sector. The system then has to wait until the desired sector comes around again. CP/M solves the problem by staggering the data (from multiple-sector files) throughout the diskette. This gives the system a little more time between the end of one sector and the beginning of the next. Of course, all this manipulation is not apparent to the user.

STARTUP

After you have customized your version of CP/M and loaded it into memory (as discussed later in this article), it can be started up by branching to address zero. The prompt A> appears at the console, indicating that CP/M is ready for commands and that drive A is the default drive.

Some commands will also accept ambiguous file names as a reference to a group of files. The asterisk and question mark are used for this purpose. The * stands for any number of characters; the ? for only one. Thus the ambiguous file name *,* refers to all files on the disk.

THE BUILT-IN COMMANDS

Several commands, built into CP/M, can now be given:

DIR	List directory of files
ERA	Erase file(s) from disk
REN	Rename a file
SAVE	Copy a file from memory to disk
TYPE	Print out a file

Keyboard entries can be edited with the following commands (^X means Control-X):

^U	Cancel the current line
DEL	Delete the last character
^R	Retype the current line
^E	Local carriage return (don't send it)

Other special commands are:

^C	Restart CP/M (warm start from address zero)
^P	Output to list device (toggle on and off)
^S	Freeze/scroll the display (toggle)

The DIR command, without arguments, lists the entire directory on the default drive. An argument may also be given to list only a portion of the directory or to specify the disk drive.

FILE NAMES

File names may be ambiguous or unambiguous. Unambiguous file names may have three parts: the disk name, the primary name, and the file type. The following are examples of unambiguous file names:

```
B:SOLVIT.ASM
A:LINEAR.HEX
LOGGING.DAT
B:MAR2878
```

The drive name appears first, followed by a colon. If the file is on the default drive, then the drive name is optional. The primary name must start with a letter and may contain up to eight characters. The file type is used to designate the nature of information in the file. It is preceded by a decimal point.

Some file-types are reserved by the system:

ASM	Assembler source file
HEX	Intel HEX object file
PRN	Print file of assembly listing
COM	Command file (binary executable file)
BAS	BASIC source file
INT	Intermediate BASIC file
BAK	Backup file from prior edit
LIB	Library source file that can be inserted during editing
SUB	A list of commands to be executed
DAT	Data file
\$\$\$	Temporary work file

The user can also invent other names, e.g., TXT for text.

Some commands will also accept ambiguous file names as a reference to a group of files. The asterisk and question mark are used for this purpose. The * stands for any number of characters; the ? for only one. Thus the ambiguous file name *.* refers to all files on the disk. The name INVER.* refers to all files with the primary name INVER, while *.HEX refers to all HEX files. Files named

```
NEWTON1.HEX
NEWTON2.HEX
NEWTON3.HEX
```

can be collectively referred to by

```
NEWTON?.HEX
```

THE DIR AND ERA COMMANDS

The commands DIR and ERA both accept ambiguous file names. Examples are:

DIR	List entire directory on default drive
DIR B:	List entire directory on drive B
DIR *.ASM	List all assembler source files
DIR B:PROM.*	List all files on drive B with primary name PROM
DIR *.*	Same as DIR

The ERA command is used to erase files and takes the same arguments as the DIR command. As a precaution against a potentially catastrophic error, the command ERA *.* requires verification. The user must answer the question: Y/N?. Of course, unambiguous file names can be used with the DIR and ERA commands to reference a single file.

THE REN, TYPE, AND SAVE COMMANDS

The REN, TYPE, and SAVE commands require the use of unambiguous file names. To rename a file, type the new file name, an equals sign, and the original file name (i.e., the names appear to be reversed). As we shall see in the next section, the editor gives the original file name to the new file. It then saves the original version, but changes its file type to .BAK. If this file were edited a second time, the original file would be lost. This occurs when the editor renames the intermediate file to type .BAK, and the newest version to .ASM. All three versions can be saved if the .BAK file is renamed before the second edit:

```
REN B:LIFE.BK2=LIFE.BAK
```

Now after the second edit, there will be three LIFE files of types .ASM, .BAK, and .BK2.

The TYPE command is used to list files on the console or list device. (Typing a ^P alternately turns on and off the output to the list device. It always appears at the console.)

The SAVE command is used to copy programs to disk from memory. The command:

```
SAVE 10 B:TABL.COM
```

will save on disk B a binary file ten pages (256-byte blocks) long. The program must start at 100 HEX, the beginning of the transient program area (TPA). The SAVE command is useful for saving an altered version of a binary program. It is also useful for transferring your old source files to ASM. (More about this later.)

CHANGING DISKS

References to files stored on the default drive need not include the drive name:

```
A>TYPE SOLVIT.ASM
A>TYPE A:LINFIT.FOR
```

The default drive can be changed by typing the new drive name followed by a colon:

```
A>B: You type this
B> The system responds with this
```

Now commands that refer to disk B need not be preceded with the drive name. Of course, references to files on drive A must be preceded with an A:

```
B>DIR *.ASM You type this
B:LIFE.ASM CP/M responds with this
B>DIR A:*.ASM You type this
A:FITTER.ASM CP/M types this
B>A: Switch back to A
A> A is now the default drive
```

CP/M maintains a storage map of each diskette. So when you change diskettes, you must type a ^C to re-start CP/M. Otherwise you won't be able to write on the new diskette. The commands we have just considered

are built into the CCP part of CP/M. The other commands we will consider are separate programs. Their names appear separately in the directory listing, and can be removed if they are not needed.

STAT	SUBMIT
ED	DUMP
ASM	LOAD
DDT	PIP

These transient programs will be discussed in the following sections.

DISK STATUS

The program STAT.COM can be used to find the free area of each diskette. The command:

```
A>STAT B:
```

will print the message:

```
BYTES REMAINING ON B: 27 K
```

The STAT command will produce a directory listing in alphabetical order and give the size of each file. The command is:

```
A>STAT B:.*
```

Disk drives can be software write protected with the command:

```
STAT B:=R/O
```

A warm start (^C) will cancel the protection. Also, the default drive cannot be write protected.

THE TEXT EDITOR

Disk files are created and altered with the command:

```
A>ED filename.type
```

A * prompt will appear, indicating that the editor is ready for commands. If you are creating a new file, type an I (for insert) and a carriage return <CR>. All of the next lines will be entered into the edit buffer in memory. At the end of the test, type a Control-Z (^Z) and the * prompt will reappear. The text you have written can now be displayed or altered. The commands you can use make reference to an imaginary character pointer (CP) that is positioned between two adjacent characters in the edit buffer. Some of the commands move the CP, others manipulate the text with respect to the CP.

MOVING THE CHARACTER POINTER

The pointer is set to the beginning of the buffer with a B and to the end with a —B. A command of C moves the CP one character forward (towards the end of the buffer). The CP can be moved to the beginning of the next line with an L. The pointer-movement routines don't produce any output, so you can't see what is actually happening. In the next section we will introduce additional commands for viewing the text. Either the C or L commands can be preceded by a decimal number to move the CP more than one location. If the number is negative, the pointer moves backwards. A 0L command sets the CP to the beginning of the current line. These commands are summarized in Table 2.

Table 2. Editor commands that move the pointer.

Command	moves the pointer
B	to the beginning of the edit buffer
—B	to the end of the buffer
nC	n characters forward
—nC	n characters backwards
nL	to the beginning of the nth line
—nL	backwards n lines
OL	to the beginning of the current line

VIEWING THE TEXT

The T command can be used to view (Type) lines of the edit buffer. Typing a single T, displays the text from the CP to the end of the line. A OT, prints text from the beginning of the line to the CP. Since commands can generally be combined, the command OTT types the entire line that the CP is on. A positive or negative decimal number may precede T as with the C and L commands. The editor can be made to simulate a line-oriented editor. Typing just a carriage return will move the CP to the beginning of the next line and print that line. This is equivalent to entering an LT command. Of course successive lines can be viewed by repeatedly typing a carriage return <CR>.

Text can be altered, inserted, or replaced. The n D command deletes n characters after the CP if n is positive. If n is negative, the n characters before the CP are deleted.

Typing a decimal number n and a <CR> will move the CP n lines and print out the new line. Each prior line can be viewed by typing a —1<CR>.

If scrolling is too fast during execution of the T command, you can type a Z or two. This slows down the display (sleep Z-Z-Z).

ALTERING THE TEXT

Text can be altered, inserted, or replaced. The n D command deletes n characters after the CP if n is positive. If n is negative, the n characters before the CP are deleted. The nK command is similar, except that it deletes (kills) n lines of text starting the the CP. Characters are inserted after the CP with the I command. The insert mode is terminated either with a ^Z or a <CR>. The latter is used if both a <CR> and line feed are to be inserted into the edit buffer. Otherwise the ^Z is used. These additional commands are summarized in Table 3.

Table 3. Edit commands that operate on the text

T	Display from CP to end of line
OT	Display from beginning of line to CP
Z	Slow down scroll speed (sleep)
nD	Delete n characters after the CP
—nD	Delete n characters before the CP
nK	Delete n lines (kill)
—nK	Delete n lines before the CP
—I	Insert text after the CP
<CR>	Move the CP to next line and print it
n	Move the CP n lines and print the last

THE FANCY COMMANDS

There are several fancy commands. Typing an F<string> will move the CP to the end of the string. A decimal number may precede the F to find the nth occurrence of the string. Notice that the F command doesn't change the text. The search/substitute command is often the best method of changing a passage. The format is nS<old string>^Z<new string> (the angle brackets are not actually entered). This command will change the next n occurrences of the old string to the new. Carriage return/line feed pairs are represented in the string by a Control-L.

The X command can be used to block move a portion of text. Typing an 8X, for example, will copy the eight lines after the CP to a temporary disk file. You then move the CP to the new position and type the R command. The eight lines are then copied from the disk file to the new location in the edit buffer. Finally, there is an M (macro) command that can be used to repeatedly execute the rest of the command line. Examples of these commands are given in Table 4.

Table 4. Fancy edit commands.

2FCALL^ZOTT	Find the 2nd occurrence of CALL and print the line it is on
MS^^Z^ZOTT	Change every occurrence of " to ' and print the new lines

When you have finished editing the text, type an E <CR> (End). The edit buffer will be copied to disk and control will return to CP/M.

EDITING EXISTING FILES

In the previous section, we were talking about creating and editing a file. The editing of an existing file (on disk) is a little different. Give the same initial command:

ED filename.type

But if you then give the BT commands to move the pointer to the beginning of the file and print the first line, all you get is the * prompt. In fact, any of the above commands will only produce a * prompt. The problem is that the edit buffer is empty. (This problem didn't occur before, because we were creating the file directly in the edit buffer.) The answer is to append some text from the old disk file.

Files small enough to be contained in the edit buffer can be loaded with the command #A. The # sign stands for 65535 and can be used for any command that needs a decimal number. Now that the entire file is in memory, it can be displayed with the command B#T. Edit the text, then type an E to end the edit. The new version will be copied back to the disk and given the original name. The original version is saved too; its file type is changed to .BAK.

Disk names can be used in the ED command to specify where to get the editor, where to set the original file, and where to place the final version. The command:

A>B:ED A:FORCE.ASM C:

will load the editor from drive B, the original file from disk A and put the edited version on disk C. In this case, C will become the default drive at the end of the edit.

EDITING LONG FILES

Files that are too long to fit into the edit buffer can be edited in parts. (You may wonder how such a long file can be used. As we shall see shortly, the assembler operates on a disk source file and puts its results back onto the disk. Thus it is possible, in principle, to assemble huge source files.) The command 200A will copy 200 lines from the source file into the edit buffer. After editing this part, copy it back to disk with the command #W. (There may be more or less than 200 lines after the edit, so we use the # symbol.) The sequence of 200A/#W commands can be repeated as often as necessary.

A>ED B:NEWTON.ASM	Edit NEWTON on drive B
*200A	Copy 200 lines to edit buffer
<edit commands>	
*#W	Copy edited lines to disk
*200A	Get 200 more lines
<edit commands>	
#W	Copy edit buffer to disk
#A	Get the rest of the lines
<edit commands>	
*E	End edit

The E command is then used to end the edit. Any text remaining in the edit buffer is copied to the new disk file (thus it is not necessary to give a #W command prior to the E command). Then any lines left in the original disk file are copied to the new file. The new file is given the old file name and the old file type is changed to type .BAK.

LIBRARY FILES

You probably have sections of assembly language code that you frequently use, such as I/O routines and HEX-binary/binary-HEX conversions. These routines can be placed into a disk file of type .LIB and subsequently inserted into another file that is being edited. The command:

*B HEXBIN

copies the file HEXBIN.LIB from disk into the edit buffer, starting at the CP.

THE ASSEMBLER

The CP/M assembler operates on disk files of type .ASM. It can produce an assembly listing file (a combination of ASCII HEX code and the original source listing) with the file type .PRN (print). It is called a print file, because it is useful only for humans. Computers have no use for such a listing. A checksummed hexadecimal file in the Intel format can also be produced (of type .HEX). This file contains the assembled machine code. The assembler can be directed to save the .PRN and .HEX files on any available disk, or to output them to the printer, or to not generate them at all.

The assembler uses the standard Intel op codes and

the usual pseudo-op codes DB, DS, DW and ORG. Both the DB and DW directives allow multiple arguments which may be mixtures of ASCII and constants.

DB 'Checksum error',CR,LF,'at ',0

The ORR pseudo-op has no meaning, since the assembler doesn't actually put the resulting machine code into memory.

There is also a conditional assembly pseudo-op:

IF NAME

,

,

ENDIF

which allows you to maintain one master source file containing several versions. For example, my main monitor can be assembled with or without VDM capabilities and with either North Star or PerSci disk commands. The portion of text between the IF/ENDIF pairs is assembled if NAME is true (not zero). Near the top of the program, the statement:

FALSE	EQU	0
TRUE	EQU	NOT FALSE

could be given. Then the statement:

NORTH	EQU	TRUE
-------	-----	------

would cause assembly of the conditional parts headed by:

IF NORTH

but skip assembly of parts headed with:

IF NOT NORTH

Labels can contain up to 16 characters and need not be terminated with a colon. Imbedded \$ symbols are ignored, and so can be used for legibility. The assembler is designed to read free-formatted code, so commands can start in any field. More than one statement may appear on each line if separated by an exclamation point.

RAR ! RAR ! RAR ! RAR ;MOVE TO LOWER HALF

Numerous operations are possible in operands:

+	add	-	subtract
*	multiply	/	divide
AND	logical AND	OR	logical OR
NOT	complement	XOR	exclusive OR
SHR	shift right	SHL	shift left

Parentheses can be used to insure the desired hierarchy of operations.

ASSEMBLY-TIME OPTIONS

Several options can be selected with the assembly command:

command	source on	HEX on	PRN on
A>ASM WORK	A	A	A
A>ASM WORK.BBB	B	B	B
A>ASM B:WORK	B	B	B
A>ASM WORK.ABC	A	B	C
A>ASM WORK.BXZ	B	printer	none

The source file must be of type .ASM, but the .ASM must not be entered in the command. If all action is on the same disk, the file name can be preceded with the disk name. An alternate format is also available. The location of the source file, and the disposition of the HEX and PRN files can be specified by three letters in the file-type location. The letters A,B,C and D designate

a disk drive. X sends the output to the console/list device, and Z indicates that generation is to be omitted. The first letter designates the source, the second refers to the HEX file, and the third letter is for PRN file.

A DEBUGGER CALLED DDT

CP/M comes with a powerful dynamic debugging tool (DDT). It is a transient program that is loaded with the command:

A>DDT

After the prompt — (minus) appears, DDT can be used to perform such common monitor functions as: dump memory in HEX and ASCII, fill memory with a constant, and move a block of memory. DDT can disassemble machine code into the 8080 mnemonics and directly assemble individual instructions. For example, there is a Go command which sets the enable interrupt, and then jumps to an absolute address. Before I jump out of CP/M to my PROM monitor, I enter a short program with DDT.

```
—A F000<CR>
  DI<CR>
  JMP F800<CR>
  <CR>
—G F000<CR>
```

DDT jumps to F000 where the instructions will disable the interrupts, then jump to my monitor at F800.

An assembled program can be debugged with the command:

A>DDT CERAM.COM<CR>

The executable program CERAM is loaded at 100 HEX. The program counter will initially be set to 100 HEX so that a G command (without arguments) will start execution of the program. One or two breakpoints can be set with the G command, so that the test program can be terminated prematurely. All of the 8080 registers can be inspected and altered with the X command. There are additional commands which allow a program operation to be fully traced.

HEX files are more conveniently loaded with the commands:

```
—I filename.HEX
—Ra
```

where the argument a is an optional load offset. (HEX files contain the load address at the start of each record.) After assembling my monitor for F800 HEX, I can load the resulting HEX file into the beginning of the user's area (100 HEX) with the command:

```
—I PRM.HEX<CR>
—R 900<CR>
```

FILE TRANSFER

Files can be transferred from disk to disk or from any peripheral to any other by using the transient program PIP. For example:

A>PIP B:PENCIL.COM = A:

will copy the binary file PENCIL from drive A to B. Notice that the order appears reversed, as with the REN command. All files on drive A can be copied to drive B with the command:

A>PIP B: = *,*

PIP can be used to combine several files into a master file. Thus:

A>PIP B:NEW.FOR = B:SORT.FOR,PLOT.FOR

will produce a file on drive B with the name NEW.FOR from the two files SORT on drive B and PLOT on drive A. With this PIP command, you have to be patient. There will be disk activity, then nothing for a while, then more disk activity. But finally, just when you think the system died, the CP/M prompt will appear indicating that all is well.

GETTING UP AND RUNNING

It's easier to get up and running the first time if you already have a disk operating system and an assembler. You have to write the routines that will interface CP/M to your I/O devices. CP/M has the ability to use several peripherals, such as a video screen, printer, punch, tape reader, etc. But it is better to get started with a minimum system using only console I/O. Then when you have CP/M running, you can use it to generate a more sophisticated system (BIOS).

The first thing you should do is make a copy of the CP/M diskette, and save the original for a backup. If you have only one disk drive, you can make a copy by alternately transferring portions of the original diskette into memory, switching to the new diskette, and copying back. If you don't have a disk operating system, it may be difficult to get CP/M running.

GETTING STARTED WITH THE LIFEBOAT VERSION

If you have a North Star system, you can get the Lifeboat Associates version of CP/M running in a matter of minutes. Assemble your BIOS for 4400 HEX. Load North Star DOS in the usual way, and then switch to the new CP/M diskette. Type the command:

WR 28 4400 2<CR>

The North Star DOS will copy your BIOS onto the CP/M diskette. Now give the command:

JP E900<CR>

DOS will jump to the bootstrap loader in PROM and start up CP/M. From now on, you can start CP/M by addressing E900.

FULL-SIZE FLOPPIES

With an eight-inch floppy disk, you may have a bit more work to do. You will need some routines that interface CP/M to your disk as well as to the other peripherals. Assemble your BIOS for the address 3E00 HEX and copy it onto Track 1, Sectors 18-21.

The disk interface programs took me a while to write. The problem was with the track- and sector-lookup routines. CP/M sends its request in binary, and I was using a PerSci intelligent interface that wanted ASCII decimal input. I therefore had to include a binary-to-ASCII conversion routine. Furthermore, both CP/M and the PerSci controller perform cyclical-redundancy checks. I suppose that these factors are partly responsible for the noticeably slow operation. The controller comes with a serial option that also causes a slowdown. (I understand that PerSci has a new version of its DOS available that accepts binary input and is designed for parallel operation only. This should make interfacing easier, and perhaps increase the speed.)

It looks like one of the dumb-interface boards available from Tarbell or S.D. Sales is a good way to go. These apparently come with software (or firmware) that should make it much easier to get CP/M going. I will have the Tarbell unit shortly, and will devote an article to it in a forthcoming issue.

ENLARGING THE SYSTEM

CP/M does its work in the transient program area (TPA) between 100 and 28FF HEX. If you have more than the minimum memory, you should enlarge CP/M so that it will have more work space. This is easily accomplished with the routines on the CP/M diskette (if you don't follow the confusing instructions in the manual). There are several ways of accomplishing the expansion; the more sophisticated, use CP/M entirely.

I did the enlarging before I was familiar with all the CP/M commands, so it isn't the most efficient. Nevertheless, since I was able to accomplish the task, I will show you how it can be done on the North Star system. You will need an initialized diskette, and the best way to get one is to make another copy of CP/M.

To generate a nominal 46K system (which requires 50K of memory), type:

```
A>NRELOC 46 *
```

The system responds with:

```
CONSTRUCTING 46 K CP/M
READY FOR "SYSGEN" OR
"SAVE 38 CPM46.COM"
```

Now type:

```
A>NSYSGEN
```

and you get:

```
SYSGEN VERSION 1.1
GET SYSTEM?           (answer N)
PUT SYSTEM?
```

Answer Y if you have more than one disk and put an initialized diskette into drive B. If you have only one drive, answer A and replace the 16K diskette with an initialized diskette. A verification message appears next:

```
SOURCE ON B [or A], THEN TYPE RETURN (do it)
FUNCTION COMPLETE
REBOOTING, TYPE RETURN.
```

If you typed an A to the PUT SYSTEM? command, switch back to the 16 K CP/M diskette before typing return.

The new version of CP/M won't run yet because it doesn't have your customized BIOS. Reassemble your I/O routines to run at the new address:

```
MSIZE* 1024 + 400H (Lifeboat version)
```

where MSIZE is the new nominal size in decimal K (46 in the above example). Copy the reassembled BIOS to address 28 as you did at the very beginning. Now a cold start (jump to E900) will load the new, larger system.

If you have an 8-inch floppy, give the commands:

```
A>CPM 46 *
A>SYSGEN
```

rather than NRELOC and NSYSGEN. Reassemble your BIOS to:

```
MSIZE* 1024 — 200H      (8-inch disk)
```

and copy it to Track 1, Sectors 18-21.

CONVERTING YOUR OLD SOURCE PROGRAMS

You can copy your old assembly language source files to CP/M disk files, and then assemble them after making a few alterations. The CP/M editor stores both a carriage return and line feed at the end of each line. My MITS source files contain only a carriage return. Furthermore, CP/M expects a pair of apostrophes to delimit ASCII characters, but my old source files use quotation marks.

The CP/M editor can insert a carriage return/line combination, but it can't insert just a line feed. Therefore, I had to preprocess my source files. The easiest way to

make the conversion is to replace all line feeds with something else not used in the text (e.g., a # symbol). Then copy the file to CP/M and use the S command to replace the # with the CR/LF pair (where ^L stands for CR/LF). I couldn't do this at first, since my monitor uses ^L to switch output to the list device.

The program shown below will add a line feed after each carriage return and will also change each quote to an apostrophe. I used my North Star DOS to load the file into memory starting at 4000 HEX, then jumped to my monitor and block moved the source program to 2C00 HEX. I started up CP/M and executed my ADDLF.

```
A>ADDLF
```

```

; PROGRAM TO ADD LF TO MITS SOURCE PROGRAMS
;
; APRIL 14, 1978
;
0100      ORG 100H
;
2100 =    OLD EQU 2C00H ;START OF ORIGINAL
2200 =    NEW EQU 2200H ;START OF NEW VERSION
;
0100 11002C START: LXI D,OLD ;OLD POINTER
0103 210022      LXI H,NEW ;NEW POINTER
0106 1A          NEXT: LDAX D ;GET A BYTE
0107 FE22        CPI     ' ' ;LOOK FOR QUOTE
0109 C20E01      JNZ     SKIP ;CHANGE TO '
010C 3E27        MVI     A,39 ;PUT INTO NEW FILE
010E 77          SKIP: MOV     M,A ;INCREMENT POINTERS
010F 13          INX     D ;LOOK FOR 0 OR 1
0110 FE02        CPI     2
0112 DA2101      JC      DONE
0115 23          INX     H
0116 FE0B        CPI     0DH ;CARRIAGE RETURN?
0118 C20601      JNZ     NEXT ;NO
011B 360A        MVI     M,10 ;PUT LINE FEED IN
011D 23          INX     H ;INCREMENT POINTER
011E C30601      JMP     NEXT ;NEXT BYTE
;
0121 361A        DONE: MVI     M,1AH ;PUT "Z" AT END
0123 C300F8      JMP     0F800H ;JUMP TO PROM
0126             END

```

A>

ADDLF will copy the source file starting at 2C00 to 2200, making the necessary changes until either a binary one or zero is found. (I use a binary one for an end-of-file (EOF) marker). ADDLF puts a 1A HEX (^Z), the EOF marker for CP/M, at the end. When ADDLF is done (it takes only seconds), it jumps to my monitor so that I can inspect the new file and block move it down to 100 HEX. A jump to address zero will restart CP/M so that the converted source file can be saved. The command: SAVE 20 filename.ASM will copy a 20-block file to the default drive. There must be an easier way, but at least this method works.

PROGRAMS THAT RUN ON CP/M

There are several interesting programs designed to run with CP/M. No modification is necessary; just put the diskette in and type the program name. Three BASICs are available: BASIC-E, CBASIC, and Microsoft BASIC. The first two compile your source program from disk and put the resulting code back onto disk. The compiled code should run much faster since instructions in loops aren't continually being re-interpreted. Also there is no need for a 12K or 16K BASIC to be taking up memory. The disadvantage of a compiled code is that it may be harder to debug.

The Microsoft BASIC appears to be a CP/M version of MITS disk BASIC. Microsoft also has a CP/M version of FORTRAN that sounds yummy. It would certainly make data reduction in our thermodynamics lab easier.

I expect to have BASIC-E, a macro assembler called MAC and a debugger called SID running shortly; I will give you a report on them in the near future.

Next month I will report on the CP/M version of Michael Shrayner's Electric Pencil, a very versatile paragraph-oriented text editor. I used Electric Pencil to compose, edit and format this CP/M article. □

TMS 9900 Interactive Monitor

— Part II

By Burt Johnson

In Part One of this article, I discussed the general philosophy and design of the 9900 monitor. In this part the unassembled listing is provided for those readers who wish to emulate the design.

Table 1 is a review list of all the functions provided within this monitor. Table 2 is a summary of the commands available.

I believe that those of you who have 9900 based machines will find this an extremely useful tool to use as is, or in the development of your own interactive software.

VARIABLE DEFINITION
INTERRUPT VECTORS
MAINLINE
HANDLERS FOR QUICKIE COMMANDS
TRACE CONTROL
LIST (DIS-ASSEMBLE)
GENERAL SUPPORT ROUTINES
DOWNLOAD FROM HOST COMPUTER
INTERRUPT HANDLERS
PXXX — PRINT STATUS, REGISTER
OPCODE HANDLERS FOR OUTPUT
ASSEMBLY INPUT
ASSEMBLY INPUT TYPE HANDLERS
PARSE INPUT FOR ASSEMBLER
TS FLAG HANDLER FOR OUTPUT
TABLES
CONSTANTS
OPTIONAL TABLE
OPTIONAL COMMAND PROCESSORS
DECIMAL INTEGER PRINT
DECIMAL TO HEX AND HEX TO
HANDLE AUTO-HARDCOPY
RAM TEST WITH WALKING ONES
OUTPUT EXECUTION TIME AND MEMORY
PAPER TAPE SUPPORT
TIMING TABLE

Table 1.

```

* DDT99 COMMANDS SUMMARY ---
*
* 1 ALL NONDIGIT NONCOMMAND CHARACTERS AMMMMI SET BREAKPOINT TO MMMM
* 8 MMMM NNS FULL TRACE NN INSTRUCTIONS STARTING AT MMMM
* 9 MMMM NNT TRACE SAME AS 'S' EXCEPT PRINT ONLY REGISTERS THAT
*   CHANGED DURING INSTRUCTION EXECUTION
* 10 MMMM NNJ SAME AS 'T' EXCEPT SKIP PAST ALL BL AND BLWP
*   INSTRUCTIONS FOLLOWING ANY SKIPPED BL OR BLWP, ALL REGISTERS
*   WILL BE PRINTED OUT USING THE 'S' FORMAT, FOR A SINGLE INSTRUCTION
* 11 MMMM NNNN DEPOSIT NNNN AT MMMM AND INCREMENT ADDRESS TO NEXT WORD
* 12 MMMMW SET WP TO MMMM FOR USERS PROGRAM
* 13 P PRINT SUMMARY DATA
* 14 MMMM NR SET REGISTER N TO MMMM
* 15 K OR I TRANSFER TO KRONOS MODE
* 16 MMMM NNO QUICK DUMP NN MEMORY LOCATIONS STARTING AT MMMM
* 17 SPACE CONTINUES TRACE FOR SINGLE INSTRUCTION OTHERWISE
*   IGNORED
* 18 BS BACKSPACE NUMERIC ENTRY (CONTROL-H)
* 19 MMMM NNNN KKKKZ SET ADDRESS SPACE MMMM TO NNNN EQUAL TO
*   HEX VALUE KKKK
* 20 MMMM NNL LIST NN INSTRUCTIONS BY MNEMONIC
* 21 ALTMODE (MODE SWITCH) ---
*   KRONOS = < DDT99
*   DDT99 = < ASM
*   ASM = < DDT99
* 22 MMMMQ SET USER STATUS TO MMMM
* 23 MMMM NNNN KKKKM START RAM TEST FROM ADDRESS MMMM TO NNNN
*   DELAY KKKK LOOPS BETWEEN WRITE AND READ SEQUENCES TO
*   TEST DYNAMIC RAM REFRESH CIRCUITRY
* 24 OH TURN OFF AUTO-HARDCOPY MODE (OR JUST 'H')
* 25 IH TURN ON AUTO-HARDCOPY MODE (OR ANY NON-ZERO DIGIT FOLLOWED BY 'H')
* 26 X COLDSTART DDT99 RESETTING ALL VARIABLES
* 27 MMMMN STOP TRACE AT ADDRESS MMMM EVEN IF NN INSTRUCTIONS HAVE NOT
*   BEEN COMPLETED
* 28 V START TIMING IF PRESENTLY OFF OR PRINT PRESENT TIME AND
*   TERMINATE TIMING MODE IF PRESENTLY ON
* 29 NV FOR NON-ZERO N PRINT PRESENT TIME AND CONTINUE TIMING
* 30 NNNNS CONVERTS HEX TO DECIMAL AND DECIMAL TO HEX
* 31 MMMM NNNN CNTL P PUNCH PAPER TAPE OBJECT CODE
*   FROM ADDRESS MMMM TO NNNN
* 32 <CNTL R> READ PAPER TAPE OBJECT CODE IN <CNTL P> FORMAT
*
* NAM VARIABLE DEFINITION
R0 EQU 0
R1 EQU 1
R2 EQU 2

```

Table 2.

PROGRAM LISTING

```

R3 EQU 3
R4 EQU 4
R5 EQU 5
R6 EQU 6
R7 EQU 7
R8 EQU 8
R9 EQU 9
R10 EQU 10
R11 EQU 11
R12 EQU 12
R13 EQU 13
R14 EQU 14
R15 EQU 15
RAM EQU $E600
CRLF EQU $0400
ORG RAM
INT20AT R5S 2
INTFLAG R5S 2
WPDOT99 R5S 32
WPINT2 R5S 32
WPINT3 R5S 32
WPBUG2 R5S 32
WPBUG3 R5S 32
WPBUG4 R5S 32
WPBUG5 R5S 32
WPTMNL R5S 32
USEKWP R5S 32
WPHOLD R5S 66
KRONOS R5S 2
USRWP R5S 2
USRPC R5S 2
USRST R5S 2
BRKPNT R5S 2
BRKPASS R5S 2
EDIT1 R5S 2
EDIT2 R5S 2
TRACTYP R5S 2
TRACTRN R5S 2
COUNT R5S 2
TAR R5S 2
WORD1 R5S 2
WORD2 R5S 2
WORD3 R5S 2
WORD4 R5S 2
OLATOP R5S 2
LINE R5S 2
DELAT1 R5S 2
HARDCP R5S 2
MASCHEM R5S 2
OPTIONS R5S 2
HALTAD R5S 2
SPEED R5S 2
ACCESS R5S 2
BUSY2 R5S 2
HEXD5Y EQU $E018
BREAK EQU $E01A
TQUART EQU $E01C
TCQUART EQU TQUART+*F10C
KQUART EQU $E01E
KCUART EQU KQUART+*F10D
TAPQUART EQU TQUART
TAPQUART EQU TQUART
RSTBP EQU 1
NAM INTERRUPT VECTORS
ORG 4
WORD WPDOT99,INT1 I1
WORD WPINT2,INT2 I2
WORD WPINT3,INT3 I3
NAM MAINLINE
ORG $F300
JMR START EASY USER RETURN
COLDSTR JMP RSTRT
TOPMEM MOV UINIT,TQUART INITIALIZE UARTS
MOV CTQUART,TQUART
MOV UINIT,KQUART
MOV CTQUART,KQUART
RSTRT MOV CL,BRKPN1 TURN OFF BREAKPOINT LATCH
MOV CL,BREAK TURN OFF BREAKPOINT VARIABLE
LWPI WPDOT99 FORCE CORRECT WP IN CASE OF BRANCH TO HERE
LI R0,USRWP
MOV R3,USRWP DEFAULT USER STATUS HAS INT MASK = 2
MOV R3,USRST
CLR BUSY2
CLR DELATIM
CLR SPEED
CLR COUNT TOP OF PAGE
CLR HARDCP DEFAULT TO NO AUTO-COPY
CLR MASCHEM DEFAULT IS NOT TO SEND TO KRONOS
CLR OPTIONS DEFAULT TO NO OPTION TABLE
C $E606,HELL01 IS THE TABLE THERE?
JNE NDOPTS VERIFY IT
JNE NDOPTS
INC OPTIONS THE TABLES DO EXIST
RWP MESAG GIVE SALUTATION
WORD CRLF
ORG $V1.2'

```

```

EVEN
WORD 0
BEGIN CLR HALTADD
      CLR INTFLAG
      CLR KRONOS
      LI R0,WPDOT99
      LI R1,INT1
      LI R2,4
      MOV R0,*R2+
      MOV R1,*R2+
      LI R0,WPINT2
      MOV R0,*R2+
      LI R1,INT2
      MOV R1,*P2+
      LI R0,WPINT3
      LI R1,INT3
      MOV R0,*R2+
      MOV R1,*R2+
      STAKT LWP1 WPDOT99
            BLWP MESAG
            WORD CRLF
            FCC '2 '
            WORD 0
CMNDRTY CLR R0
CMNGSET CLR R12
      CLR RSTBP
      CLR RSTBP
      LIMI *1
      NO PRIOR INTERRUPTS WILL BE ACKNOWLEDGED
      DEFAULT TO LOCAL MODE
      SET INT VECTORS IN CASE SITTING IN RAM
      FORCE CORRECT WP FOR BRANCH
      PROMPT USER
      CLEAR BREAKPOINT BEFORE ENABLING MASK
      TURN OFF INTERRUPT HARDWARE
      OPEN INTERRUPT MASK
      TEST FOLLOWING IDLE ALLOWS OTHER INTERRUPTS TO BE HANDLED
      INDEPENDENTLY
CMNDWAT IDLE
      CLR INTFLAG
      INT2 ASSUMED
      GET INPUT STRING
      LAST CHAR IN R1
      COMPOUND NUMBER IN R0 (CURRENT NUMBER)
CMNDHIT MOV KRONOS,R9
      JNE CMNDWAT
      MOV OPTI04S,R9
      JEO NOPT
      LI R9,OPTTAB
      BL SRCHTAB
      LI R9,CMDTAB
      BL SRCHTAB
      BLWP UNASCTI
      MOV INT2DAT,R1
      JLT CMNDWAT
      JLT CMNDWAT
      SLA R0,4
      A R1,R0
      JMP CMNDWAT
      IN KRONOS MODE?
      IS OPTIONAL PROM IN PLACE?
      OPTIONAL TABLE EXISTS --- IS THIS COMMAND IN THERE?
      SEARCH OPTIONAL TABLE
      WAS NOT IN OPTIONAL TABLE --- CHECK STANDARD TABLE
      NOT A COMMAND --- IS IT A DIGIT?
      IF NOT COMMAND OR DIGIT, IGNORE IT
      INPUT CHAR IS HEX DIGIT --- MPY OLD NUMBER BY 16
      ADD NEW DIGIT TO CREATE CURRENT NUMBER
      SET NEXT COMMAND
      SEARCH SPECIFIED TABLE TO DETERMINE IF INPUT CHARACTER IS
      A VALID COMMAND --- BRANCH TO SPECIFIED HANDLER IF SO
SRCHTAB C INT2DAT,*R9+
      JEO GETHIT
      C *R9,ENDTAB
      JNE SRCHTAB
      R *R11
      MOV *R9,R9
      B *R9
      NAM HANDLERS FOR QUICKIE COMMANDS
      FOUND A COMMAND MATCH
      END OF TABLE YET?
      KEEP SEARCHING TILL FOUND OR END OF TABLE HIT
      CHAR IS NOT IN TABLE
      FOUND COMMAND IN TABLE, PULL TRANSFER ADDRESS
      TRANSFER TO HANDLER
      MHHM-NNG
SHRTJMP B CMNDWAT+2
EXECUTE MOV R1,RCBPASS
GOAGAN MOV USRWP,R13
      MOV USRWP,R14
      MOV USRST,R15
      LI R0,GOHIT
      MOV BRKPNT,BREK
      CLR INTFLAG
      MOV R15,R9
      ANDI R9,7
      JNE *+4
      INC R15
      RTWP
      MOV INTFLAG,*1
      CDC C2,R1
      JEO SHRTJMP
      CDC C1,R1
      JNE CLRFLG
      DEC BRKPASS
      JGT GOAGAN
      BLWP PSTATUS
      SETO TRACTYP
      CLR COUNT
      B FULDATA
      SAVE # TIMES TO PASS BREAKPOINT
      BRING USER WP TO R13
      BRING USER PC TO R14
      BRING USER ST TO R15
      SET UP POINTER FOR INT1 ROUTINE
      TURN ON BREAKPOINT
      NO INTERRUPT FLAGS
      CHECK USERS STATUS
      IF USERS INTERRUPT MASK IS ZERO ...
      ... SET TO ONE TO KEEP BP ALIVE
      TRANSFER TO USERS PROGRAM
      WHAT INTERRUPT WAS HIT?
      IF INT2 ---
      INTERPRET TERMINAL COMMAND
      IF NOT INT1 OR INT2 ---
      GO BACK AND WAIT
      COUNT PASS THROUGH LOOP
      PRINT STATUS
      FLAG 'JUMP' IF CONTINUED
      ONE ONLY
      USE TRACE DUMP ROUTINE
      MHHM-
XFRVCTP SZC C1,R0
      MOV R0,USRWP
      JMP SHRTJMP
      FORCE ADDRESS TO BE EVEN
      HOLD CURRENT NUMBER AS USER PC
      JMP SAVES PROM OVER 0
      MHHM,
EDITST MOV R0,EDIT1
      JMP SHRTJMP
      HOLD CURRENT NUMBER AS START OF EDIT WINDOW
      MHHM1
EDITSTP MOV R0,EDIT2
      SHRTJMP B CMNDRTY
      SAVE CURRENT NUMBER AS END OF EDIT WINDOW
      MHHM,NHNN=
EQUALS MOV R0,R1
      A EDIT1,R0
      BLWP PRINTS
      BLWP PRINTO
      MOV EDIT1,R0
      S R1,R0
      BLWP PRINTS
      BLWP PRINTO
      JMP QUIKEND
      PRINT SUM OF WINDOW START AND CURRENT NUMBER IN HEX
      PRINT SUM IN DECIMAL TOO
      PRINT DIFFERENCE OF WINDOW START AND CURRENT NUMBER IN
      ... AND IN DECIMAL
      WAIT FOR NEXT COMMAND
      MHHM1
BRKSET MOV R0,BRKPN1
      JMP QUIKEND
      SAVE CURRENT NUMBER AS BREAKPOINT ADDRESS
      MHHM,NHNN=
DEPOSIT MOV EDIT1,R1
      SZC C1,R1
      MOV R0,*R1
      INCT EDIT1
      JMP QUIKEND
      GET EDIT POINTER
      ASSURE WORD BOUNDARY
      DEPOSIT CURRENT NUMBER INTO MEMORY
      MOVE EDIT POINTER TO NEXT WORD
      MHHM1
SETWP SZC C1,R0
      MOV R0,USRWP
      JMP QUIKEND
      ASSURE WORD BOUNDARY
      SAVE CURRENT NUMBER AS USERS WP

```

```

      MHHM,RN
      SETREG BLWP GETNUM
      WORD 1
      ANDI R0,EF
      SLA R0,1
      A USRWP,R0
      MOV EDIT1,*R0
      JMP QUIKEND
      GET REGISTER NUMBER
      (SINGLE DIGIT)
      TAKE ONLY LAST DIGIT FOR CURRENT NUMBER TO BE REGISTER 1
      CURRENT NUMBER * 2 = REGISTER ADDRESS OFFSET
      R0 = REGISTER ADDRESS IN MEMORY
      SAVE EDIT POINTER IN REGISTER SPECIFIED
      K 09 /
      KRONON INCT KRONOS
      JMP QUIKEND
      TURN ON KRONOS FLAG
      '05'
      BACKSPC SPA R0,4
      B CMNDGET
      CURRENT NUMBER / 16 TO BACKSPACE
      CMNDGET
      MHHM,NHNN:KKKKZ
      SETHEM MOV EDIT1,R1
      MOV EDIT2,R2
      MOV R0,*R1+
      C P2,R1
      JLT QUIKEND
      JMP *-6
      START OF EDIT WINDOW
      END OF EDIT WINDOW
      SAVE CURRENT NUMBER IN MEMORY
      KEEP GOING?
      MHHM0
      SETSTAT MOV R0,USRST
      QUIKEND B START
      SAVE CURRENT NUMBER AS USER STATUS
      MHHM<CNTL-0>
      LINDELA MOV R0,DELATIM
      JMP QUIKEND
      SAVE DELAY COUNT
      'ALT MODE'
      ALTHIT MOV KRONOS,R1
      CLR KRONOS
      MOV R1,R1
      JNE QUIKEND
      BLWP ASMBLWP
      JMP QUIKEND
      SAVE KRONOS FLAG
      REGARDLESS OF PRIOR MODE, YOU ARE NOW UNDER DOT99 CONT'
      WHAT MODE WERE WE IN BEFORE?
      IF WE WERE IN KRONOS MODE, SWITCH TO COMMAND MODE
      IF WE WERE IN COMMAND MODE, SWITCH TO ASSEMBLY INPUT MC
      <SUBOUT>
      RUBOUT MOV R13,USRWP
      MOV R14,USRWP
      MOV R15,USRST
      B BEGIN
      SAVE USER REGISTERS
      N
      STOPTRC MOV R0,HALTADD
      JMP QUIKEND
      SAVE MSA AS SOFTWARE HALT ADDRESS
      MHHM,NNG
      QUIKOMP SLA R0,1
      JNE *+4
      INCT R0
      A EDIT1,R0
      SZC C1,R0
      DECT R0
      MOV EDIT1,R1
      SZC C1,R1
      MOV R0,R3
      C R1,R3
      JM QUIKEND
      BLWP RETURN
      MOV R1,R0
      MOV R1,R0
      CLR TAB
      BLWP PRINTS
      BLWP BLANKS
      MOV *R1+R0
      BLWP PRINT
      BLWP MSG01
      WORD R23
      C R1,R3
      JM CHAROUT
      MOV R1,R4
      ANDI R4,EF
      JNE QUIKLOP
      BLWP TABOVFP
      WORD 50
      CURRENT NUMBER * 2
      FORCE 0 INTO 2
      ENDING ADDRESS OF DUMP
      ASSURE WORD BOUNDARY
      R1=CURRENT ADDRESS
      ASSURE WORD BOUNDARY
      R3 = END ADDRESS
      END OF DUMP YET?
      START NEW LINE
      R0 HAS TITLE ADDRESS
      AT LEFT OF SCREEN
      PRINT ADDRESS
      MAKE IT 4 SPACES AFTER ADDRESS
      CONTENTS OF NEXT MEMORY LOCATION TO 00
      PRINT DATA
      PRINT 1 SPACE
      END OF DUMP AREA YET?
      IF SO,GO TO PRINT ASCII EQUIVALENTS
      IF NOT, TRUNCATE ADDRESS ...
      ... TO FIND START OF LINE AT MULTIPLES OF #13
      BRING BACK DATA AS PRINTED ON THIS LINE
      PRINT ASCII DIRECTLY OF MEMORY TO REVEAL TEXT STRINGS
      NON-PRINTABLE ASCII ARE PRINTED AS '.'
      CHARLOP MOV R0,*R4+R2
      SLA R2,1
      SZC R2,R9
      CI R2,R60
      JGT NONPRINT
      CI R2,R1F
      JGT QUIKCHR
      NONPRINT LI R2,*+
      INC B05Y2
      BLWP TRMSEND
      C R0,R1
      JLT CHARLOP
      JMP QUIKTTI
      NAM TRACE CONTROL
      MHHM-NNS
      STEP CLR TRACTYP
      JMP RUN
      FLAG FULL-BLOWN TRACE
      MHHM-NNT
      TRACE MOV C1,TRACTYP
      JMP RUN
      FLAG QUICK TRACE
      MHHM-NNJ
      JUMP SETO TRACTYP
      SETO TRACTYP
      HANDLE S, T, AND J
      RUN MOV R3,COUNT
      RUN*0R? INC B05Y2
      MOV USRWP,R13
      MOV USRWP,R14
      MOV USRST,R15
      MOV R13,R0
      LI R1,16
      LI P2,WPBOLD
      MOV *R0,*P2+
      DEC R1
      JNE *+4
      MOV TRACTYP,TRACPRN
      MOV R14,R4
      HOLD CURRENT NUMBER AS NUMBER OF INSTRUCTIONS TO TRACE
      PULL USER WP
      PULL USER PC
      PULL USER ST
      HOLD USER REGISTER FOR FUTURE COMPARISONS
      KFER REGISTERS
      MAKE TEMP PRINT FLAG = REQUESTED PRINT FLAG
      SAVE USER PC

```

SOFTWARE SECTION

SOFTWARE APPLICATION

```

RUNCHK  MOV #08,79      CHECK TYPE OF INSTRUCTION ABOUT TO EXECUTE
        ANDI R9,7FFC    MASK INSTRUCTION
        C P9,BLMMJ      IS THIS BL?
        JEQ RUNMMJ      IS THIS BLMP?
        C P9,BLMPMMJ
        JNE K2MMJ
RUNMMJ  MOV TRACPT,R2    DO WE WANT TO SKIP SUBROUTINES??
        JLT SKIPMMJ      IF SO, TELL USER ABOUT SUBROUTINE WE WONT TRACE
NONMMJ  LT R0,TRACINT    POINTER FOR INT1 HANDLER
        MOV #BLRKPNT     SET BREAKPOINT AFTER ANY ROUTINES NOT BEING TRACED
        MOV R4,BFAK      TURN ON HARDWARE BREAKPOINT
        MOV R4,WEKOSY     WRITE CURRENT ADDRESS TO LED SO TERMINAL CAN BE TURNED
        MOV R15,R1        CHECK USER STATUS
        ANDI R1,7         IF USER INTERRUPT MASK IS SET TO 7EFO ...
        JNE #*4
        INC R15           SET TO ONE TO ALLOW BP TO CONTINUE TRACING
        RTR              EXECUTE USER INSTRUCTIONS
SKIPMMJ  CLR TRACPRN      GIVE FULL STATUS AFTER SKIPPING SUBROUTINE
        INCI BAKPNT       PLACE BREAKPOINT AT NEXT WORD
        BLWP MESAG        TELL USER OF SUBROUTINE WE PASSED BY
        WORD CRLF
        FCC #SB, *
        EVEN
        WORD 0
        MOV R4,R0
        AT R4,4           BL AND BLWP ARE BOTH TWO WORDS LONG
        BLWP PADDIN       PRINT INSTRUCTION THAT WAS SKIPPED
        JMP RUNCHK        GO CHECK TO SEE IF ANOTHER SUBROUTINE CALL IS CONTIGUOUS
RUNMORE *
*      PRINT APPROPRIATE DATA AFTER INT1 HIT DURING T, S OR J
*
TRACINT BLWP RETURN      GO TO NEW LINE
        MOV COUNT,R0
        BLWP PRINTS       PRINT # INSTRUCTIONS LEFT TO EXECUTE
        MOV SPEZD,R1      SHOULD WE TIME IT?
        JEQ KEEPON
        MOV SEAR2,R0      YES -- GET ADDRESS FROM OPT FROM ANH ...
        B #0              ... BRANCH TO TIMING SOFTWARE
KEEPON  JNE TRACPRN,R0    BREAKPOINT HIT --- HOW DETAILED A REPORT IS WANTED?
        BLWP RETURN
        CLR TAB           SPACE DOWN AN EXTRA LINE
        CLR WORD1          AT EDGE OF SCREEN
        CLR WORD2
        MOV BKPNT,R1
        CFC CL,R0          IS BREAKPOINT ON?
        JEQ NOBPK         SKIP IF NOT
        BLWP PADDIN       PRINT BREAKPOINT ADDRESS AND INSTRUCTION
        BLWP TABOVR       TAB TO COLUMN 30
        WORD 10
NOBPK   MOV USRP,R0       PRINT NEXT ADDRESS AND INSTRUCTION TO BE EXECUTED
        BLWP PADDIN       OUTPUT CONTENTS OF ANY MEMORY LOCATIONS REFERENCED
        BLWP RETURN
        CLR TAB
        BL CHKWORD
        WORD WORD2
        BL CHKWORD
        WORD WORD1
        MOV TAB,R0
        JEQ #*6           WERE ANY LOCATIONS PRINTED?
        BLWP RETURN       IF SO, ...
        BLWP PREGSTR       ... SKIP TO NEXT LINE
        BLWP PREGSTR       OUTPUT CONTENTS OF ALL OF USERS WP REGISTERS
TRACDGN CLR BUSY2
        C BKPNT,HALTAD    IS THIS A SOFTWARE HALT ADDRESS?
        JNE TRACNT
        LT R2,7           IF S7, STOP AND ...
        RL R2,R0
        DEC R2            RING BELL LOUD
        JNE #*6
        B START
TRACNT  DEC COUNT        COUNT NUMBER OF TRACED INSTRUCTIONS
        JST RUNMORE       WANT STILL MORE?
        LIMIT 3           IF NOT ...
        INCL              ... WAIT TO SEE IF SPACE ASKS FOR MORE
        CLE INTFLAG,IT    WAS INT? ...
        CLE INT2DAT,SPACE ... WAS IT A SPACE?
        JEQ RUNMORE       IF SO GO ONE MORE INSTRUCTION
        CLR R0
        B CHNDMT          IF NOT, USE IT AS COMMAND?
QUICKTRC MOV BKPNT,R0    ONLY A TRACE SUMMARY IS DESIRED
        CLR TAB
        BLWP PADDIN       PRINT ADDRESS AND INSTRUCTION JUST EXECUTED
        BLWP TABOVR       TAB TO COLUMN 35
        WORD 15
        BL CHKWORD
        WORD WORD2
        BL CHKWORD
        WORD WORD1
        MOV USRP,R1
        CLR #1            GET USRP REGISTER SET
        LT R4,WP0HOLD     #1 IS COUNTER FOR REGISTER CHECK LOOP
        MOV #R1,*R4       GET COPY OF USERS SET BEFORE LAST INSTRUCTION WAS EXEC
QUICKCHK C #R1,*R4       WAS THIS REGISTER CHANGED?
        JNE QUICKNEG      IF IT WAS, PRINT IT
        INCT R1            IF NOT, PASS IT BY
        INCT R4
        INC R1             COUNT TO NEXT REGISTER
        CFI R3,15         CHECKED ALL 16 REGISTERS YET?
        JNE QUICKCHK      IF NOT, CONTINUE LOOP
        JMP TRACDGN       IF SO, CHECK TO SEE IF TRACE IS COMPLETED
QUICKREG MOV R3,R0       PULL REGISTER NUMBER TO R0
        C TAB,C0          IS SCREEN WIDTH FILLED YET?
        JLT QUICKNTT
        BLWP RETURN
        CLR TAB           IF SO, START NEW LINE ANH ...
        BLWP TABOVR       ... TAB OVER TO COLUMN 20
        WORD 20
QUICKNTT BLWP REGNUM      OUTPUT REGISTER NUMBER
        BLWP #ESG1
        WORD #0
        MOV #R1,R0        GET REGISTER CONTENTS
        BLWP PRINTS       PRINT CONTENTS OF REGISTER
        JMP QUICKING       GO CHECK NEXT REGISTER
        NAM LIST FCIS=ASSEMBLER
*
*      *****
*
LIST     CLR LINE         TOP OF PAGE
        MOV R0,R4        SAVE CURRENT NUMBER AS # INSTRUCTIONS TO LIST
        MOV EDIT1,R0      START LISTING AT START OF EDIT WINDOW
        BLWP RETURN       START NEW LINE
        BLWP PADDIN       PRINT ADDRESS AND INSTRUCTION OF INSTRUCTION
        MOV WP0HDS,R0     GET ADDRESS OF NEXT INSTRUCTION
        DEC R4            GET NUMBER OF INSTRUCTIONS LISTED THUS FAR
        JST LISTLSTP      IF NOT ENOUGH, DO ANOTHER
        MOV R0,EDIT1      NOW EDIT POINTER TO NEXT WORD AFTER LIST
        B START           WAIT FOR NEXT COMMAND
*      NAM GENERAL SUPPORT ROUTINES
*
*      GET # DIGITS SPECIFIED FOLLOWING CALL (MAX 4)
*      RETURNS NUMBER IN R0 OF CALLING WP
*
GETNUM  MOV WP0HDS        BLWP POINTERS
        WORD #*2
        MOV #2144,R4      GET # DIGITS REQUESTED
        CLR R0            CURRENT NUMBER IS ZERO
GETITLE LIMIT 4           MASK OFF ALL ELSE IN DOWNLD SEQUENCE

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```

IDLE                                WAIT FOR KRONOS TO TALK
C INFLAG,CH                         C INFLAG,CH
JEO NUH00NE                         STOP IF CARRIAGE RETURN SENT
C INFLAG,BAKSPAC                    C INFLAG,BAKSPAC
JEO NUH00DO                          BACKSPACE EDIT ALLOWED
OL4 INFLAG                          ASSUME KRONOS SENT IT
BLWP INASG11                         GET HEX VALUE FROM ASCII
MOV INT02041,R1                     R1 IS NUMBER SENT BY KRONOS
JLT GETDILE                          NOT VALID INPUT --- IGNORE IT
SL4 R0,4                             MPY OLD NUMBER BY 16 AND ...
A R1,R0                              ADD NEW DIGIT TO GET CURRENT NUMBER
DEC R4                              COUNT DIGITS HANDLED
JST GETDILE                          IF NOT ENOUGH,GET ANOTHER
MOV R0,*R13                         RETURN CURRENT NUMBER TO CALLER'S REG
NUH00NE RTWP                         RETURN
NUH00DO SRS R3,R4                   BACKSPACE BY SHIFTING OFF LAST DIGIT
INC R4                              DO NOT COUNT LAST DIGIT
JMP GETDILE                          GET NEXT DIGIT
*
* SEND RIGHT BYTE OF R2 TO TERMINAL
*
TSO                                MOV T0UART,R9                     CHECK IF UART READY
COC C1,R9                          COC C1,R9
JNE TSD                             IF NOT, WAIT UNTIL IT IS
MOV R2,T0UART                      SEND DATA TO TERMINAL
MOV R2,R9
ANDI R2,7FF
CI R0,R0
JNE TSD004                          DID WE SEND <LF>?
MOV DELATIM,R9                     IF SO, DELAY AS REQUIRED
JEO TSD00N
DEC R9
JNE *-2
TSD00N B *R11
*
* SEND RIGHT BYTE OF R2 TO KRONOS
*
KSD                                MOV K0UART,R9                     IS KRONOS READY TO RECIEVE DATA?
COC C1,R9                          IF NOT, WAIT UNTIL IT IS
JNE *-8                             MOV R2,K0UART  MOV CALLERS R2 TO KRONOS DATA YART
B *R11
*
* SEND RIGHT BYTE OF R2 TO TERMINAL AND TAKE CARE OF CONTROLLING
*
* PAGE AND SPACE COUNTS
*
TRMSND WORD WPTRINL                BLWP POINTERS
WORD *+2
MOV 4(WR13),R2                     GET CALLERS R2
ANDI R2,7FF                         MASK FOR ASCII
JEO TRMDON                          IF ZERO --- QUIT
BL TSD                              SEND WORD TO TERMINAL
INC TAB                             COUNT CHARACTERS ON LINE
MOV OPTIONS,R9                     IS AUTO-HARDCOPY REQUESTED?
JEO TRMDON                          IF NOT, QUIT
MOV SEND0,P11                      GET ADDRESS OF UPLOAD HANDLER
B *+11                              TRANSFER CONTROL TO IT
TRMDON RTWP
*
* DELAY BY N LOOPS WHERE N IS SUPPLIED FOLLOWING CALL
*
DELAY                                MOV *R11+,DLATMP
HOLDOFF MOV CLUART,DLALOP          GIVE INTERNAL LOOP 15 LONG
DEC DLALOP
JNE *-4
DEC DLATMP                          FELL OUT OF INNER LOOP
JNE HOLDOFF                         RUN THIS TILL EMPTY TOO
B *+11                              RETURN
*
* OUTPUT MESSAGE TO TERMINAL FOLLOWING CALL
*
* MESSAGE TERMINATED BY WORD 0
*
MSG0                                WORD WPBUS2                      BLWP POINTERS
WORD *+2
MSG0L0P MOV *R14+,R2               GET WORD TO OUTPUT AS ASCII
JNE *+6                             IF WORD IS ZERO ...
RTWP                                ... RETURN
SWPB R2                             IF NON-ZERO, OUTPUT LEFT BYTE...
BLWP TRMSND
SWPB R2
BLWP TRMSND
JMP MSG0L0P                        CHECK NEXT WORD
*
* PRINT SINGLE WORD FOLLOWING BLWP CALL AS ASCII ( 2 CHARACTERS)
*
MSG1                                WORD WPBUS2                      BLWP POINTERS
WORD *+2
MOV *R14+,R2
SWPB R2
BLWP TRMSND                        PRINT LEFT BYTE
SWPB R2
BLWP TRMSND                        PRINT RIGHT BYTE
RTWP                                RETURN
*
* OUTPUT TWO SPACES TO TERMINAL
*
BLANKS                                WORD WPBUS2                      BLWP POINTERS
WORD *+2
LI R2,R20
BLWP TRMSND                        PRINT SPACE
BLWP TRMSND
RTWP
*
* PRINT CR-LF TO START NEW LINE
*
RETURN                                WORD WPBUS2                      BLWP POINTERS
WORD *+2
LI R2,CR,LF
BLWP TRMSND                        PRINT CR
SWPB R2
BLWP TRMSND                        PRINT LF
RTWP
*
* TAB TO COLUMN INDICATED FOLLOWING BLWP CALL
*
* ALWAYS PRINT AT LEAST ONE SPACE TO SEPARATE TEXT EVEN IF
* FIRST PART IS TOO LONG
*
TAP0VR                                WORD WPBUS2                      BLWP POINTERS
WORD *+2
MOV *R14+,R0                       GET COLUMN NUMBER TO TAB TO
S TAB,R0                           SUBTRACT CURRENT POSITION
LI R3,R20                           PRINT 1 SPACE AT A TIME
BLWP TRMSND
DEC R0
JGT *-6
RTWP                                GO DO ANOTHER SPACE IF NOT TO POSITION YET
RETURN
*
* CONVERT NUMBER IN R2 TO ASCII
*
* CALLED VIA BL ASCII
*
ASCII                                ANDI R2,7F                       TRUNCATE TO SINGLE DIGIT
CI R2,10
JLT *-6
AI R2,7                             A TO F, ADD 37
AI R2,*30                           0 TO 9, ADD 30
B *R11
*
* CREATE BINARY NUMBER OUT OF ASCII CHARACTER IN INT02041
*
* SETS INT02041 TO -1 IF INPUT DATA WAS NOT A HEX DIGIT

```

```

*
UNASCII WORD WPBUG2      BLWP POINTERS
WORD **2
MOV INT2DAT,R9
AI R9,FFD0             -30
CI R9,10
JLT **45              0 TO 9, SUBTRACT *30
AI R9,FFFF9           1 TO F, SUBTRACT *37
MOV R9,INT2DAT
JEO **8
JST **6
SETO INT2DAT          IF DIGIT NEGATIVE, IT IS NOT A VALID HEX DIGIT
CI R9,510
JLT **45
SETO INT2DAT          IF DIGIT > 5F, IT IS NOT A VALID HEX DIGIT
RTWP

*
* THIS ROUTINE COMBINES THREE OTHERS INTO ONE SO AS TO SAVE PROM
*
* PRINT ADDRESS FOLLOWED BY INSTRUCTION AT THAT ADDRESS (WITH TWO SPACES &
* INPUT --- RC OF CALLING ROUTINE POINTS TO WORD TO BE PRINTED
*
PADDINS WORD WPBUG5      BLWP POINTERS
WORD **2
MOV *R13,R0           GET CALLER'S PC
BLWP PRINT            PRINT ADDRESS REFERENCED
BLWP BLANKS           SPACE TEXT
BLWP PINSTPC          PRINT INSTRUCTION THIS CORRESPONDS TO
RTWP

*
* THIS ROUTINE COMBINES A COUPLE OF FREQUENTLY CALLED ROUTINES TO SAVE PROM
*
* PRINT 4 HEX DIGITS OF AN ADDRESS FOLLOWED BY TWO SPACES
*
PRINTS WORD WPBUG5       BLWP POINTERS
WORD **2
MOV *R13,R0           GET CALLER'S PC
BLWP PRINT            PRINT USER'S PC
BLWP BLANKS           SPACE TEXT
RTWP

*
* PRINT 'RN' WITH N SUPPLIED IN RC OF CALLING ROUTINE
*
REGNUM WORD WPBUG2       BLWP POINTERS
WORD **2
LI R2,*R
BLWP TRMSEND          PRINT 'R'
MOV *R13,R2           GET REGISTER NUMBER
AL ASCII              TRANSFORM NUMBER INTO ASCII AND ...
BLWP TRMSEND          ... PRINT IT
RTWP

*
* PRINT HEX NUMBER IN R0 OF CALLING ROUTINE
*
PRINT WORD WPBUG2        BLWP POINTERS
WORD **2
MOV *R13,R1           BRING CALLING R0 TO THIS P1
LI R0,12              R0 HAS SHIFT COUNT
PRINTLP MOV R1,R2       SAVE REQUESTED NUMBER
SRC R2,0              CIRCULAR SHIFT TO PUT DESIRED DIGIT IN RIGHT 4 BITS
BL ASCII              CONVERT THESE RIGHT 4 BITS TO ASCII AND ...
... PRINT IT
AI R0,-4              SHIFT BY 4 LESS NEXT TIME
JST PRINTLP           GO TILL SHIFT COUNT GOES NEGATIVE
JEO PRINTLP
RTWP

*
* PRINT ONLY ONE DIGIT OF R0 IN CALLING PROGRAM
*
PRINT1 WORD WPBUG2       BLWP POINTERS
WORD **2
MOV *R13,R1           GET CALLER'S R0 TO THIS R1
PRELOAD SHIFT COUNT AND ...
... BASTARDIZE 'PRINT'

*
* PRINT 2 DIGIT NUMBER PASSED IN R0 OF CALLING ROUTINE
*
PRINT2 WORD WPBUG2       BLWP POINTERS
WORD **2
MOV *R13,R1           GET CALLER'S R0 TO THIS R1
PRELOAD SHIFT COUNT AND ...
... BASTARDIZE 'PRINT'

*
* PRINT SYMBOLIC ADDRESS AND CONTENTS AS POINTED TO FOLLOWING CALL
*
CHKWORD MOV *R11,R0      WORD FOLLOWING CALL HAS ADDRESS TO BE PRINTED
MOV *R0,R0             GET ADDRESS DESIRED
JVC **4               ADDRESS = 0 FLAGS THAT IT IS NOT TO BE PRINTED
B *R11
MOV R11,R1             SAVE RETURN POINTER
BLWP PRINT            PRINT ADDRESS REQUESTED
BLWP MSG1             PRINT **
WORD **=
MOV *R0,R0             GET CONTENTS OF SPECIFIED REGISTER
BLWP PRINTS           PRINT CONTENTS
B *R1
NAM DOWNLOAD FROM HOST COMPUTER

*
* KRONOS DOWNLN
*
DOWNLN LIMI 4           TURN OFF OTHER INTERRUPTS
IOLE
MOV INT2DAT,R2
CI R2,*5
JEO DOLLAR
CI R2,15
JNE DOWNLN
B START
BLWP GETNUM           GET ADDRESS OF LINE (4 CHAR = 2 BYTES)
WORD 4
MOV R0,R1             SAVE STARTING ADDRESS
MOV R1,R3
ANDI R3,FFF
SRL R0,4
XOR R0,R3             CHECKSUM IS VIA EXCLUSIVE OR
BLWP GETNUM           GET LINE LENGTH (2 CHAR = 1 BYTE)
WORD 2
MOV R0,R5
XOR R0,R5
BLWP GETNUM           R3 HAS RUNNING CHECKSUM
WORD 2
GET SUM CHECK (2 CHAR = 1 BYTE)
WORD 2
LI R7,*P
C R0,R3
JNE DOWNLN
CLR R1
BLWP GETNUM           GET A BITS OF DATA
WORD 2
XOR R1,R3
SLA R0,8
MOV R0,*R1
DEC R5
JGT MORDOWN
BLWP GETNUM           LOAD BYTE RECEIVED INTO MEMORY
WORD 2
C R0,R3              COUNT LINE LENGTH
IF NOT DONE WITH LINE, GET NEXT BYTE
GET SUM CHECK
SUMCHECK OK?
MORDOWN

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JNE DOWNLN
LI R7,*
SUM CHECK FINE
WAIT FOR KRONOS TO SIGNAL READY
DOWNLN IOLE
MOV INT2DAT,R2
CI R2,*7
JNE DOWNLN
IOLE
MOV INT2DAT,R2
CI R2,*
JNE DOWNLN
WAIT FOR PROPER CHARACTER AGAIN
BL DELAY
WORD 200
MOV R7,R2
BLWP BLWPKSD          SEND * * OR *R* TO KRONOS
LI R2,500
BLWP BLWPKSD          SEND CR TO KRONOS
JMP DOWNLN
BLWPKSD WORD WPBUG5
WORD **2
MOV *R13,R2
BL KSD
RTWP
NAM INTERRUPT HANDLERS

*
* INT1 IS BREAKPOINT
*
* R9 MUST HAVE HANDLER ADDRESS BEFORE ROUTINE GETS HERE
*
INT1 MOV R13,USRWP      SAVE LOCATION INTERRUPTED FROM AS USER VECOTROS FOR WP,,
MOV R14,USRPC          ...PC...
MOV R15,USRST          ... AND STATUS
MOV C1,BREAK           RENDER BREAKPOINT INOPERABLE
CLR R12
SND RSTDP              TURN OFF INTERRUPT HARDWARE
S3Z RSTDP
S0C C1,INTFLAG
B *R0                  SET INTFLAG SO WAITING ROUTINE CAN USE IT
BRANCH THROUGH PRE-LOADED POINTER IN R0

*
* INT2 IS TERMINAL
*
* INT3 IS KRONOS
*
INT3 MOV KQUART,R2      GET KRONOS DATA
C R2,0C4
JEO DOWNLN
CLR R10
BL T01
S0C C3,INTFLAG
ANDI R2,FFF
CI R2,514
JVC **4
JNE **4
B DOWNLN
JMP INT2OUT            DO NOT ALLOW ECHOING OF KRONOS TO KRONOS
INT2E0 BLWP TRMSEND     ECHO KRONOS INFORMATION TO TERMINAL
INT2OUT ANDI R2,5FF     MASK OFF HIGH ORDER GARBAGE
MOV R2,INT2DAT         SAVE DATA IN INT2DAT
MOV R10,R10            WHERE DID THIS DATA COME FROM?
JEO INT2D0N            IF KRONOS SENT, DO NOT CHECK FURTHER
MOV KRONOS,R9          NO LF ADDITION IF TALKING TO KRONOS
JNE INT2D0N
MOV MASSMEM,R9
JNE INT2D0N
CI R2,500
JNE INT2NCR
BLWP RETURN            SEND LF AFTER CR IF SENT BY TERMINAL
CI R2,5FF
JVC **4
B PUBOUT              IF PUBOUT, FORCE RETURN TO D0T99 CONTROL
JNE **4
INT2D0N RTWP            IF NOT, RETURN
INT2 RTWP              GET TERMINAL DATA
MOV TQUART,R2
ANDI R2,FFF
MOV WUSY2,R9
JNE INT2NCR
MOV C1,R10
S0C C2,INTFLAG
MOV KRONOS,R3
JEO INT2E0
MOV KQUART,R9
C0C C1,R9
JNE **8
MOV R2,KQUART
C R2,ALTM00
JNE INT2OUT
LIMI 0
BL DELAY
WORD *R00
B KESTRT
NAM PXXX --- PRINT STATUS, REGISTER SET, AND INSTRUCTION

*
* INPUT ADDRESS OF INSTRUCTION IN R0 OF CALLING ROUTINE
*
* CALL VIA BLWP PINSTPC
*
* OUTPUTS CODE TO TERMINAL AND ADDRESS OF NEXT INSTRUCTION IN R3
*
* OF WPBUG5
*
PINSTPC WORD WPBUG5     BLWP POINTERS
WORD **2
LI R4,PNTAB            *NUMONIC TABLE ADDRESS
MOV *R13,R3            ADDRESS OF INSTRUCTION TO BE PRINTED
MOV *R3,R5             GET OPCODE TO TEST
MOV *R4,R0             GET OPCODE MASK
SRL R5,3
SLA R5,0
C R5,*R4
JEO CODFN1
AI R4,6
C *R4,ENDTAB
JNE CODSRCH
BLWP MSG5             IF NOT, CHECK NEXT CODE IN TABLE
FDC *WORD *
WORD 3
NOT A VALID OPCODE
MOV *R13,R0            GET ADDRESS DECODED AGAIN
MOV *R0,R3             GET CONTENTS OF THAT ADDRESS AND...
BLWP PRINT            ... PRINT IT
MOV *R13,R0            GET ADDRESS AGAIN
INCR R0
POINT TO NEXT WORD AS NEXT LOCATION TO BE DECODED
RTWP
CODFN0 MOV *R4,R5       FOUND CODE ... GET TYPE
MOV *R4,R2             OUTPUT NUMONIC
SWPB R2               PRINT 1ST CHR FROM NUMONIC TABLE
BLWP TRMSEND
SWPB R2               PRINT 2ND CHAR
BLWP TRMSEND          ETC.
SWPB R2
BLWP TRMSEND
BLWP TRMSEND
BLWP BLANKS
DEC R5
SLA R5,1
AI R5,TPYTAB
MOV *R5,R5
CLR WORD1
CLR WORD2
B *R5                 BRANCH TO TYPE HANDLER

*
* PRINT CONTROL REGISTERS

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*
PSTATUS WORD WPBUG3      BLWP POINTERS
WORD *+2
BLWP RETURN              START NEW LINE
MOV BRKPTR,R0             GET BREAKPOINT ADDRESS
COC C1,R0                 IS BREAKPOINT ADDRESS 0007
JEO PSTATPC               IF SO, DON'T PRINT IT
BLWP MSG1                 PRINT BREAKPOINT MESSAGE
FCC *I=
BLWP PRINTS               PRINT BREAKPOINT ADDRESS
PSTATPC BLWP MESAG        PRINT PROGRAM COUNTER MESSAGE
FCC * PC=
WORD 0
MOV USRPC,R0              PRINT USERS PC
BLWP PRINTS               PRINT WORKSPACE POINTER MESSAGE
FCC * WP=
WORD 0
MOV USRWP,R0              PRINT USERS WP
BLWP PRINTS               PRINT STATUS MESSAGE
BLWP MESAG                FCC * ST=
WORD 0
MOV USHST,R0              PRINT USERS STATUS
BLWP PRINT
RTWP RETURN

*
* PRINT REGISTER SET POINTED AT BY USRWP
*
*
PREGSTR WORD WPBUG3      BLWP POINTERS
WORD *+2
CLR R5                    R5=REG #
MOV USRPC,R4              R4=REG POINTER
JMP PREGLOP
PREGRET BLWP RETURN       START A NEW LINE (BUT NOT FIRST TIME THROUGH)
PREGLOP  MOV R5,R0         PRINT RX (X = REGISTER NUMBER)
BLWP REGNUM
BLWP MSG1
WORD *+
MOV *R4+,R0               GET CONTENTS OF REGISTER
BLWP PRINTS               PRINT REGISTER CONTENTS
INC R5                    COUNT REGISTERS
C1 R5,8                   AFTER # 7 ...
JEO PREGRET               ... START NEW LINE
C1 R5,16                  IF NOT YET 16 ...
JVC PREGLOP               ... CONTINUE TO NEXT REGISTER
RTWP RETURN
NAM OPCODES HANDLERS FOR OUTPUT

*
* TRANSFERRED HERE FROM PINSIC INDIRECTLY THROUGH TABLE TYPTAB
*
*
* TYPE 1 OUTPUT HANDLER
* ARITHMETIC OPCODES
* 1,2, OR 3 WORDS
*
T1  MOV *R13,R5           GET ADDRESS OF INSTRUCTION
MOV *R5+,R3              GET INSTRUCTION
MOV *R5+,R4              GET FOLLOWING WORD
BLWP TRCTAG              DECODE SOURCE IS FLAG
MOV WORD1,WORD2          SAVE SYMBOLIC REFERENCE ADDRESS (IF ANY)
BLWP MSG1                PRINT *,
FCC *,
A R0,R5                  POINT TO PROPER NEXT WORD
MOV *R5+,R4              GET DATA FROM PROPER NEXT WORD
MOV *R13,R3              GET INSTRUCTION ADDRESS AGAIN
MOV *R3,R3               GET INSTRUCTION AGAIN
SRL R3,6                 SHIFT TO LOOK AT DESTINATION IS
BLWP TRCTAG              DECODE DESTINATION IS FLAG
A R5,R0                  POINT TO NEXT WORD AFTER THIS INSTRUCTION
RTWP RETURN

*
* TYPE 2 OUTPUT HANDLER
* JUMP OPCODES
* 1 WORD
*
T2  MOV *R13,R0           GET INSTRUCTION ADDRESS
MOV *R0,R0               GET INSTRUCTION
SLA R0,8                 SHIFT OFF OPCODE
SRA R0,7                 SHIFT BACK ONE LESS TO GIVE BYTE DISPLACEMENT
INCR R0                  POINT TO NEXT WORD (AS POINT OF REFERENCE IN JUMPS)
A *R13,R0                ADD INSTRUCTION ADDRESS
BLWP PRINT               PRINT INSTRUCTION JUMPING TO
MOV *R13,R0              GET INSTRUCTION ADDRESS AGAIN
INCR R0                  POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 3 OUTPUT HANDLER
* LOGICAL OPCODES
* 1 OR 2 WORDS
*
T3  MOV *R13,R5           GET INSTRUCTION ADDRESS
MOV *R5+,R1              GET INSTRUCTION
MOV *R5+,R4              GET NEXT WORD
BLWP TRCTAG              DECODE IS OF SOURCE
A R0,R5                  POINT TO PROPER NEXT WORD
BLWP MSG1                PRINT *,
FCC *,
MOV *R13,R4              GET ADDRESS OF INSTRUCTION AGAIN
MOV *R4,R0               GET INSTRUCTION
SRA R0,6                 SHIFT TO LOOK AT DESTINATION IS
ANDI R0,7F              MUST BE REGISTER --- CHOP OFF REG #
BLWP REGNUM              PRINT REGISTER NUMBER
MOV R5,R0                BRING POINTER TO NEXT WORD
RTWP RETURN

*
* TYPE 4 OUTPUT HANDLER
* CRU OPCODES
* 1 OR 2 WORDS
*
T4  MOV *R13,R5           GET ADDRESS OF INSTRUCTION
MOV *R5+,R3              GET INSTRUCTION
MOV *R5+,R4              GET NEXT WORD
BLWP TRCTAG              HANDLE SOURCE IS
A R0,R5                  POINT TO NEXT WORD
BLWP MSG1                PRINT *,
FCC *,
MOV *R13,R4              GET INSTRUCTION ADDRESS AGAIN
MOV *R4,R0               GET INSTRUCTION
SRA R0,6                 SHIFT TO GET CRU LINE #
BLWP PRINT2              PRINT LINE #
MOV R5,R0                POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 5 OUTPUT HANDLER
* SHIFT OPCODES
* 1 WORD
*
T5  MOV *R13,R5           GET INSTRUCTION ADDRESS
MOV *R5,R0               GET INSTRUCTION
BLWP REGNUM              PRINT REGISTER NUMBER BEING SHIFTED
BLWP MSG1

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FCC *,
MOV *R5,R0               GET INSTRUCTION AGAIN
SRA R0,4                 SHIFT OFF REGISTER NUMBER
BLWP PRINT1              PRINT HOW FAR REGISTER HAS TO SHIFT
MOV *R13,R0              GET INSTRUCTION ADDRESS AGAIN
INCR R0                  POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 6 OUTPUT HANDLER
* PROGRAM OPCODES
* 1 OR 2 WORDS
*
T6  MOV *R13,R5           GET INSTRUCTION ADDRESS
MOV *R5+,R1              GET INSTRUCTION
MOV *R5+,R4              GET NEXT WORD
BLWP TRCTAG              HANDLE SOURCE IS
A R5,R0                  POINT TO PROPER NEXT WORD
RTWP RETURN

*
* TYPE 7 OUTPUT HANDLERS
* CONTROL OPCODES
* 1 WORD
*
T7  MOV *R13,R0           GET INSTRUCTION ADDRESS
INCR R0                  POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 8 OUTPUT HANDLER
* IMMEDIATE OPCODES (EXCEPT LIMIT --- SEE T13)
* 2 WORDS
*
T8  MOV *R13,R5           GET INSTRUCTION ADDRESS
MOV *R5+,R0              GET INSTRUCTION
BLWP REGNUM              PRINT REGISTER # TO LOAD
BLWP MSG1
FCC *,
MOV *R5+,R0              GET NEXT WORD (WHICH HAS IMMEDIATE VALUE)
BLWP PRINT               PRINT IMMEDIATE VALUE
MOV R5,R0                R5 ALREADY POINTS TO NEXT WORD
RTWP RETURN

*
* TYPE 10 OUTPUT HANDLER (NOT IMPLEMENTED ON THIS SYSTEM)
* MEMORY MAP OPCODES (NOT IMPLEMENTED)
*
T10 RTWP                  NOT IMPLEMENTED ON THIS SYSTEM

*
* TYPE 11 OUTPUT HANDLER (MY OWN SUBSET OF T1)
* SRO, SBZ, AND TB OPCODES
* 1 WORD
*
T11 MOV *R13,R5           SRO,SBZ,TB GET INSTRUCTION ADDRESS
MOV *R5+,R0              GET INSTRUCTION
BLWP PRINT2              PRINT LINE # BEING CONTROLLED
MOV R5,R0                POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 12 OUTPUT HANDLER (MY OWN SPECIAL SUBSET OF T1)
* STST OPCODE ONLY
* 1 WORD
*
T12 MOV *R13,R5           STST GET INSTRUCTION ADDRESS
MOV *R5+,R0              GET INSTRUCTION
BLWP REGNUM              PRINT REGISTER TO STORE STATUS IN
MOV R5,R0                POINT TO NEXT WORD
RTWP RETURN

*
* TYPE 13 OUTPUT HANDLER (MY OWN SPECIAL SUBSET OF T1)
* LIMIT ONLY
* 2 WORDS
*
T13 MOV *R13,R5           LIMIT ONLY -- GET INSTRUCTION ADDRESS
INCR R5                  POINT TO LIMIT SIZE
MOV *R5+,R0              GET LIMIT SIZE
BLWP PRINT               PRINT LIMIT SIZE
MOV R5,R0                POINT TO NEXT WORD
RTWP RETURN

*
* NAM ASSEMBLY INPUT
*
* ASSEMBLY INPUT
*
ASHBLWP WORD WPBUG4      BLWP POINTERS
WORD *+6
NULINPT INCR EDIT1       SKIP THIS ADDRESS IF NULL LINE WAS INPUT
RUBASH  BLWP RETURN      START NEW LINE
ASSEMB  LI R0,WPBOLD      GET INPUT BUFFER ADDRESS
LI R1,30                  COUNTER
CLR *R0+                  CLEAR INPUT BUFFER
DEC R1
JNE *+4
MOV EDIT1,R0              WILL PUT INSTRUCTION AT EDIT POINTER
BLWP PRINTS              PRINT ADDRESS INSTRUCTION WILL BE INSERTED INTO
BLWP MSG1                PROMPT USER
FCC *A=
ASHWAT  LI R1,WPBOLD      R1=INPUT BUFFER POINTER
LIMIT 4                  TURN OFF ALL OTHER INTERRUPTS DURING THIS PROCESS
JLFC 0                   WAIT FOR USER TO TYPE INPUT
MOV INT2DAT,R3            ASSUME INPUT WAS FROM TERMINAL
C R3,CR                  CARRIAGE RETURN TERMINATES LINE INPUT
JEO ASHLIN
C1 R3,8                   <BS> BACKS UP STRING
JEO ASHBACK
C1 R3,57F                 RUBOUT ERASES LINE
JEO RUBASH
C R3,ALTMOD               ALTMODE FORCES RETURN TO COMMAND MODE
JNE *+6
B START
MOV R3,*R1+              SAVE INPUT CHARACTER IN INPUT BUFFER
C R3,SPACE
JNE FULLYET
MOV R3,*R1+
MOV R3,*R1+
FULLYET C1 R1,WPBOLD+60  IS BUFFER FILLED YET?
JLT ASHWAT               GET NEXT CHARACTER IF NOT
JWP BADMMU               TELL USER HIS LINE IS TOO LONG
ASHBACK DEC R1           BACK UP ASM INPUT
MOV *R1,R4
CLR *R1
C R4,SPACE
JNE *+10
DEC R1
CLR *R1
DEC R1
CLR *R1
JMP ASHWAT

*
* START DECODING INPUT LINE UPON RECEIPT OF CR
*
ASHLIN  LI R4,MNUTAB      POINT TO FIRST SHIFT CODE IN TABLE
ASHSTR  LI R1,WPBOLD      POINT TO START OF BUFFER
LI R4,6                   POINT TO NEXT MNEMONIC IN TABLE
ASHSCAN MOV *R1+,R3       GET FIRST CHARACTER
JEO NULINPT              IF NO CHARACTER WAS INPUT SKIP MEMORY ADDRESS
C R3,SPACE
JEO ASHSCAN              SKIP STARTING SPACES

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```

ASH7  MOV R4,*R3+      SAVE OPCODE
      MOV R3,EDIT1     NEXT INSTRUCTION IN NEXT WORD
      JMP ASHJMP2      GET NEXT LINE
*
*      TYPE 8 INPUT HANDLER
*      IMMEDIATE MNUMONICS (EXCEPT LIMI --- SEE ASH13)
*      2 WORDS
ASH8  JNE PRSERR       MUST BE REGISTER
      ANDI R0,$F       REGISTER DIRECT
      SOC R0,R4        COMPLETE OPCODE
      MOV R4,*R3+      STORE OPCODE
      BLWP PARSE       PARSE IMMEDIATE VALUE
      MOV R1,*R3+      SAVE IMMEDIATE VALUE
ASHJMP3 MOV R3,EDIT1   NEXT INSTRUCTION IN NEXT WORD
      JMP ASHJMP2      GET NEXT LINE
*
*      TYPE 10 INPUT HANDLER
*      MEMORY MAP MNUMONICS
*      **** MEMORY MAP NOT IMPLEMENTED ON THIS SYSTEM ****
ASH10 JMP ASHJMP2      NOT IMPLEMENTED --- GET NEXT LINE AND IGNORE THIS ONE
*
*      TYPE 11 INPUT HANDLER (MY OWN TYPE SUBSET)
*      SBO, SBZ, TB MNUMONICS
*      1 WORD
ASH11 ANDI R1,$FF      TWO DIGITS ONLY
      SOC R1,R4        COMPLETE OPCODE
      MOV R4,*R3+      SAVE OPCODE
      JMP ASHJMP3      GET NEXT LINE
*
*      TYPE 12 INPUT HANDLER (MY OWN TYPE SUBSET)
*      STST MNUMONIC ONLY
*      1 WORD
ASH12 JNE PRSERR       MUST BE REGISTER
      ANDI R0,$F       REGISTER DIRECT
      SOC R0,R4        COMPLETE OPCODE
      MOV R4,*R3+      SAVE OPCODE
      JMP ASHJMP3      GET NEXT LINE
*
*      TYPE 13 INPUT HANDLER (MY OWN TYPE SUBSET)
*      LIMI ONLY
*      2 WORDS
ASH13 JEQ PRSERR       MUST BE SYMBOLIC
      MOV R4,*R3+      STORE OPCODE
      MOV R1,*R3+      STORE MASK VALUE
ASHJMP4 JMP ASHJMP3    GET NEXT LINE
*
*      TYPE 14 INPUT HANDLER (MY OWN SUBSET TYPE)
*      FCC ONLY
*      FOLLOW BY ARBITRARY ASCII STRING UP TO <CR>
ASH14 LI R5,$20
      MOV *R2,R7       GET FIRST CHAR IN BUFFER
      C R7,$5          IS IT A SPACE?
      JEQ *-4          STRIP LEADING SPACES
      SLA R7,8         MOVE IT TO HIGH ORDER BYTE
      MOV8 R7,*R3+     STORE CODE
      SLA R5,8         MOVE SPACE TO HIGH BYTE
STORA14 MOV *R2,R7     GET NEXT CHAR IN BUFFER
      JEQ ASH14JON    SHIFT ON ZERO WORD
      SLA R7,8         SHIFT CHAR TO HIGH ORDER BYTE AND ...
      MOV8 R7,*R3+     ... STORE IT
      C R5,R7          WAS IT A <SPACE> ?
      JNE STORA14      IF NOT, GET NEXT CHAR
      INCT R2          IF SO, THEY ARE IN TRIPPLICATE
      INCT R2
ASH14JON JMP STORA14
      CLR R5
      CDC C1,R3        WAS NUMBER OF CHARACTERS EVEN?
      JNE *-+4
      MOV8 R5,*R3+     ADD ZERO BYTE TO FILL WORD IF NOT
      JMP ASHJMP4
*
*      TYPE 15 INPUT HANDLER (MY OWN SUBSET TYPE)
*      WORD ONLY
ASH15 MOV R1,*R3+      SAVE IT
      JMP ASHJMP4
NAM PARSE INPUT FOR ASSEMBLER
*
*      PARSE INPUT FOR ASSEMBLER
*
*      INPUT -- R7 WAS BUFFER POINTER
*      OUTPUT -- R0 WAS TS OR TD
*      R1 WAS SYMBOLIC ADDRESS REFERENCED
*      STATUS IS SET TO NE IF SYMBOLIC MEMORY WAS REFERENCED
PARSE WORD WPBUG3     BLWP POINTER
      WORD *-+2
      CLR R6
      CLR R3           SYMB FLAG
      CLR R2           REG #
      CLR R1           TAG
      MOV 14(R13),R4    SYMBOL
PRSPUL MOV *R4,R5      GET BUFFER POINTEP
      JEQ PRSMPTY      GET NEXT CHAR
      C R5,SPACE       HIT END OF INPUT STRING
      JEQ PRSPUL       IGNORE SPACES ...
      CI R5,*          COMMA TERMINATES SCAN
      JEQ PRSDON
      CI R5,')         ... AND CLOSED PARENS
      JEQ PRSPUL
      CI R5,*R         R FLAGS REGISTER DIRECT
      JEQ PRSREG
      CI R5,*          * FLAGS REGISTER INDIRECT
      JEQ PRSINDG
      CI R5,*          I FLAGS INDEXED
      JEQ PRSINDX      SET TS = 3 FOR SYMBOLIC REFERENCE
      SOC C2,R2        SYMBOLIC REFERENCE
      MOV R5,INT2DAT   PULL OUT HEX DIGIT
      BLWP UNASCII
      MOV INT2DAT,R4
      JLT PRSERR       IS IT A VALID CODE?
      SLA R1,4
      A R0,R1          NEW SYMBOLIC VALUE
      JMP PRSPUL       KEEP SCANNING
PRSERR B @ADHNU       TELL USER HIS INPUT HAS BEEN REJECTED
PRSPEG MOV *R4,INT2DAT GET REG #
      BLWP UNASCII     GET HEX DIGIT
      MOV INT2DAT,R3
      JLT PRSERR
COMPLUS MOV *R4,R5
      CI R5,*          IS IT A PLUS?
      JEQ SKIPBUF
      CI R5,*          IF NOT,QUIT
      JEQ PRSDON       AUTO INCREMENT IF IT IS
      SOC C3,R2        PASS * JR - IN BUFFER
      INCT R4
      JMP COMPLUS
SKIPBUF OCT 24
PRSMPTY OCT 24
      DON'T ALLOW NEXT CALL TO RUN PAST BUFFER INTO OTHER VARS

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PRSDON SLA R2,4
      A R3,R2
      MOV R4,14(R13)
      MOV R2,*R13
      MOV R1,2(R13)
      STST R15
      RTWP
PRSDONC SOC C1,R2
      JMP PRSPUL
PRSDONX SOC C2,R2
      JMP PRSPUL

      NAM TS FLAG HANDLER FOR OUTPUT
*DECODE SYMBOL CODE
*INPUT WITH TAG IN R3, NEXT WORD IN R4
*RETURNS R0=0 IF REGISTER FIELD, R0=2 IS SYMBOLIC FIELD
*RETURNS WORD1=0 IF REGISTER FIELD=ADDRESS IF SYMBOLIC
*
TRCTAG WORD HWPUG4
      WORD *+2
      CLR WORD1
      MOV 6(R13),R3
      MOV 8(R13),R4
      SRA R3,4
      ANDI R3,R3
      JEQ TAGREG
      DEC R3
      JEQ TAGIND
      DEC R3
      JEQ TAGLAB
      BLWP MESG1
      WORD **
      MOV 6(R13),R0
      BLWP REGNUM
      BLWP MESG1
      FCC **
TAGCLR CLR *R13
      RTWP
TAGREG MOV 6(R13),R0
      BLWP REGNUM
      JMP TAGCLR
TAGIND BLWP MESG1
      WORD **
      JMP TAGREG
TAGLAB MOV 6(R13),R3
      MOV C2,*R13
      ANDI R3,R3
      JEQ TAGSYMB
      MOV R4,R3
      BLWP PRINT
      BLWP MESG1
      WORD **
      MOV R3,R0
      BLWP REGNUM
      BLWP MESG1
      WORD **
      RTWP
TAGSYMB MOV R4,R0
      MOV R0,WORD1
      BLWP PRINT
      RTWP
      NAM TABLES
*
* COMMAND TABLE HAS ASCII CHARACTER BEING RECOGNIZED,
* FOLLOWED BY TRANSFER VECTOR FOR THE ROUTINE HANDLING
* THAT COMMAND.
* THE LAST WORD IN THIS TABLE ***MUST*** BE $FFFF
*
CMDBTAB WORD $00,START
      WORD *G,EXECUTE
      WORD *X,XFRVCTR
      WORD *E,EDITSTT
      WORD *I,IITSTP
      WORD *C,CQUALS
      WORD *I,BRKSET
      WORD **DEPOSIT
      WORD *W,SETWP
      WORD *P,PCMDN
      WORD *R,SETREG
      WORD *K,KRONON
      WORD *K,KRONON
      BAKSPAC WORD $B,BACKSPC
      WORD *Z,SETMEM
      WORD *O,SETSTAT
      ALTMOD WORD $70,ALTHIT
      WORD *Q,QUICKWMP
      WORD *S,STEP
      WORD *T,TRACE
      WORD *J,JUMP
      WORD *L,LIST
      WORD *X,XOLDSTR
      WORD *N,STOPTRC
      WORD $4,LINGELA <CNTRL-D>
      ENDCHD WORD $FFFF
*
* POINT TO ASSEMBLY INPUT TYPE HANDLERS BY ---
* (TYPE# - 1) * 2 + ASMTAB
*
ASMTAB WORD ASM1
      WORD ASM2
      WORD ASM3
      WORD ASM3
      WORD ASM5
      WORD ASM6
      WORD ASM7
      WORD ASM8
      WORD ASM3
      WORD ASM10
      WORD ASM11
      WORD ASM12
      WORD ASM13
      WORD ASM14
      WORD ASM15
*
* POINT TO DIS-ASSEMBLY TYPE HANDLERS BY ---
* (TYPE# - 1) * 2 + TYPTAB
*
TYPTAB WORD T1
      WORD T2
      WORD T3
      WORD T4
      WORD T5
      WORD T6
      WORD T7
      WORD T8
      WORD T3
      WORD T10
      WORD T11
      WORD T12
      WORD T13
*
* MNEMONIC TABLE HAS ALL INFORMATION TO DRIVE ASSEMBLY (INPUT) AND
* DIS-ASSEMBLY (OUTPUT). IT CONSISTS OF ---
*
* 1) A SHIFT COUNT FOR MASKING OPCODE BEING TESTED
* 2) AN OPCODE
* 3) A TYPE NUMBER TO INDEX INTO TYPTAB OR ASMTAB

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```

* 4) A MNEMONIC TO PRINT OR RECOGNIZE
*
* THIS TABLE ***MUST*** END IN $FFFF
*
MNUTAB WORD 5
      WORD $0200
      WORD 4
      FCC *LI
      WORD 5
      WORD $0220
      WORD 8
      FCC *AI
      TWOSPAC FCC *
      WORD 0
      WORD $FF
      WORD 14
      FCC *FCC
      WORD 0
      WORD $FF
      WORD 15
      FCC *WORD
      WORD 5
      WORD $0240
      WORD 8
      FCC *ANDI
      WORD 5
      WORD $0260
      WORD 8
      FCC *ORI
      WORD 5
      WORD $0280
      WORD 8
      FCC *CI
      WORD 5
      WORD $02A0
      WORD 12
      FCC *STWP
      WORD 5
      WORD $02E0
      WORD 13
      FCC *LWPI
      WORD 5
      WORD $0300
      WORD 13
      FCC *LIMI
      WORD 5
      WORD $0340
      WORD 7
      FCC *IOLE
      WORD 5
      WORD $0380
      WORD 7
      FCC *RTWP
      CG BLWPMNU WORD $0400
      WORD 6
      FCC *BLWP
      WORD 6
      WORD $0440
      WORD 6
      FCC *FB
      WORD 6
      WORD $0460
      WORD 6
      FCC *CLR
      WORD 6
      WORD $0500
      WORD 6
      FCC *NEG
      WORD 6
      WORD $0540
      WORD 6
      FCC *INV
      WORD 6
      WORD $0580
      WORD 6
      FCC *INC
      WORD 6
      WORD $05C0
      WORD 6
      FCC *INCI
      WORD 6
      WORD $0600
      WORD 6
      FCC *DEC
      WORD 6
      WORD $0640
      WORD 6
      FCC *DECT
      WORD 6
      BLWNU WORD $0680
      WORD 6
      FCC *BL
      WORD 6
      WORD $06C0
      WORD 6
      FCC *SWPB
      WORD 6
      WORD $0700
      WORD 6
      FCC *SETD
      WORD 6
      WORD $0740
      WORD 6
      FCC *ABS
      WORD 6
      WORD $0780
      WORD 6
      FCC *LDS
      WORD 6
      WORD $07C0
      WORD 6
      FCC *LDB
      WORD 6
      WORD $0800
      WORD 5
      FCC *SRA
      WORD 8
      WORD $0900
      WORD 5
      FCC *SRL
      WORD 8
      WORD $0A00
      WORD 5
      FCC *SLA
      WORD 8
      WORD $0B00
      WORD 5
      FCC *SPC
      WORD 8
      WORD $1000
      WORD 2
      FCC *JMP

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WORD 100,0
IDLE      UPON READY PROMPT OF <LF> ...
C INT20AT,LF
JNE *-8
SETNEG   SET0 MASSMEM
B 15000  ** RESTART MONITOR
NAM DECIMAL INTEGER PRINT
PRINT0   WORD WPBUGS      WORKSPACE POINTER
WORD *+2
LI R7,WORD1  WORD1,2,... IS DIGIT BUFFER
LI R1,5      5 DIGITS POSSIBLE
CLR *R7+     CLEAR COT BUFFER
DEC R1
JNE *-4
CLR R6
MOV *R13,R3  R6=DIGIT COUNTER
CLR R2
MOV *R13,R3  GET CALLERS R0 TO THIS R1
R2=HIGH ORDER OF DIVIDEND
DECDIV   DIV R4,R2      DIVIDE NUMBER BY 10
MOV R3,*R7   STORE RESULT AS NEXT DIGIT
DEC R7       POINT TO NEXT WORD BUFFER
INC R6       COUNT DIGITS
MOV R2,R3    MOVE REMAINDER TO DIVIDEND
JEQ DECDON  IF NO REMAINDER, YOU'RE DONE
CLR R2       CLEAR HIGH ORDER AGAIN
DECDON   JMP DECDIV     CONTINUE LOOP
INC R7       POINT TO LAST DIGIT OBTAINED
MOV *R7,R0   PRINT IT AS A SINGLE DIGIT
BLWP PRINT1
DEC R6
JNE DECDON  CONTINUE BACKWARDS THROUGH BUFFER
BLWP BLANKS  PRINT TWO SPACES FOLLOWING NUMBER
RTWP        RETURN
NAM DECIMAL TO HEX AND HEX TO DECIMAL CONVERSIONS
*
*
*
DECMAL   BLWP MSGAG      INPUT NUMBER IN HEX = ...
FCC 'HEX='
WORD 0
BLWP PRINTD  ** THIS IS DECIMAL
MOV R0,R3
MOV R0,R4
BLWP MSGAG
FCC ' DECIMAL, OR '
EVEN
WORD 0
BLWP PRINT   THE SAME SAME INPUT NUMBER IN DECIMAL ...
BLWP MSGAG
FCC ' DECIMAL='
EVEN
WORD 0
ANDI R3,$F
THIS IS BRUTE FORCE MULTIPLY AND AND DIGITS
DIGIT1 * 1
DIGIT2 * 10
MOV R4,R3
SRA R1,4
ANDI R3,$F
MPY R3,R1
A R2,R0
MOV R4,R3
LI R1,100
SRA R1,8
ANDI R3,$F
MPY R1,R1
A R2,R0
MOV R4,R3
LI R1,1000
SRA R1,12
ANDI R3,$F
MPY R3,R1
A R2,R0
MOV R4,R3
LI R1,1000
SRA R1,12
ANDI R3,$F
MPY R3,R1
A R2,R0
BLWP PRINT   PRINT CONVERTED NUMBER
BLWP MSGAG
FCC ' HEX='
WORD 0
B START    RESTART MONITOR
B HANDLE AUTO-HARDCOPY
*
*
*
TRANSFER TO HERE OUT OF TRMSEND IF HARDCOPY IS REQUESTED
*
*
TSTPAGE  MOV MASSMEM,R0  IS THIS BEING UPLOADED?
JEQ NOUPLD
JGT NOUPCHK
CI R2,$00  CR?
JNE NOUPCR
BL KSD     SEND <CR> TO KRONOS AND ...
LIMI 4
MOV R13,R8
MOV R14,R7
MOV R15,R6
WAITINP  IDLE      ... WAIT FOR HOST TO GIVE <LF>
C INT20AT,LF
JNE WAITINP
LI R2,$00  SEND 'HUPLINE' TO TERMINAL TO UNDO EXTRA <LF> INSERTED BY
BL TSD
MOV R5,R15
MOV R7,R14
MOV R8,R13
BL DELAY
WORD 500
JMP KRONWAT
NOUPCR   CI R2,$04      LF?
JEQ *-6
NOUPCHK  BL KSD        DO NOT SEND LF TO KRONOS
KRONWAT  BL DELAY
WORD 10
NOUPLD   MOV HARDCOP,R3  IS HARDCOPY REQUESTED?
JEQ HARDON
CI R2,$00  IF SO, IS THIS THE END OF A LINE?
JNE HARDON
INC LINE  IF SO, COUNT LINES
MOV LINE,R9
CI R9,$34
JLT HARDON
LI R2,$171B
BL TSD
SWPO R2
BL TSD
BL DELAY
WORD $000
LI R2,$001B  CLEAR PAGE
BL TSD
SWPO R2
BL DELAY
WORD $FFF
CLR LINE
RTWP
HARDON  NAM RAM TEST WITH WALKING ONES
*
*
*
WALKING ONES RAM TEST FOR USER SPECIFIED ADDRESS RANGE
*
*
*
REGISTER USAGE---
R3  STARTING PATTERN
R4  STORING PATTERN

```

```

*
*
*
R5  STARTING ADDRESS TO TEST
R6  ENDING ADDRESS TO TEST
R7  NUMBER OF ERRORS FOUND
R8  ADDRESS BEING TESTED
R9  DATA READ DURING READ TEST
R10 LOOP COUNT
*
*
RAMTST  LI R3,$A000  STARTING PATTERN INITIALIZATION
MOV R0,COUNT  USE CURRENT NUMBER AS DELAY FOR DYNAMIC TEST
JNE *-6
INC COUNT
CLR R5
CLR R6
CLR R7
CLR R10
CLR LINE
BLWP MSGAG
WORD $1000,0
BL DELAY
WORD $1FFF
CLR R5
MOV EDIT1,R5  STARTING RAM TEST ADDRESS
MOV EDIT2,R6  ENDING RAM TEST ADDRESS
STC C1,R5     ASSURE WORD BOUNDARY
STC C1,R6     ASSURE WORD BOUNDARY
*
*
START RAM TEST
*
STRTRAM MOV R3,R4      GET STARTING PATTERN
MOV R5,R8      GET STARTING ADDRESS
RITLOP  MOV R4,*R1+    STORE PATTERN IN MEMORY
SRC R4,1
C R4,R6
JLE RITLOP     SHIFT TO 'WALK' THE ONE
MOV COUNT,R9   END OF MEMORY BLOCK YET?
LI $11,14
DEC R11
JNE *-2
DEC R2
JNE *-10
MOV R3,R4      GET STARTING PARAMETERS AGAIN
MOV R5,R8
REDLOP  MOV *R8,R9    GET NEXT MEMORY ADDRESS CONTENTS
C R9,R4
JNE ERROR     IS IT RIGHT?
IF NOT, PRINT ERR00 FOUND
INC R8
SRC R4,1
C R8,R6
JLE REDLOP    WHICH SHOULD HAVE THE BIT SHIFTED BY ONE
END OF MEMORY BLOCK YET?
READ UNTIL BLOCK COMPLETE
INC R10
MOV R10,HEXD0SY  WRITE LOOP NUMBER TO LEDS
SRC R1,1
JMP STRTRAM     TRY WHOLE PATTERN SHIFTED BY 1
ERROR   BLWP MSGAG    COUNT ERR00
WORD CRLF
FCC 'A='
WORD 0
MOV R8,R0
BLWP PRINTS    PRINT ADDRESS OF ERROR
BLWP MSGAG
FCC 'B='
WORD 0
MOV R4,R0
BLWP PRINTS    PRINT WHAT WAS WRITTEN TO CELL
BLWP MSGAG
FCC 'R='
EVEN
WORD 0
MOV R3,R0
BLWP PRINTS    PRINT WHAT WAS READ FROM CELL
BLWP MSGAG
FCC 'E='
EVEN
WORD 0
MOV R7,R0
BLWP PRINTS    PRINT NUMBER OF ERRORS FOUND SO FAR
BLWP MSGAG
FCC 'L='
WORD 0
MOV R10,R0
BLWP PRINT     PRINT LOOP NUMBER THIS ERROR WAS FOUND IN
JMP ERRBACK
WORD 100
WORD 104
NAM OUTPUT EXECUTION TIME AND MEMORY ACCESSES
*
*
*
<HEX>V
*
*
FIND WHAT INSTRUCTION IS BEING EXECUTED, AND FIND ITS
TIME OF EXECUTION AND NUMBER OF MEMORY FETCHES (WHICH
VARIES WITH ADDRESSING MODE) FOR IT. ADD THESE TIMES AND
MEMORY FETCHES TO THE CUMULATIVE TOTAL THUS FAR.
*
*
PRNTSPD CLP R6
LI R4,MNUTAB  MNEMONIC TABLE POINTER
MOV BRKPNTR,R3  BREAKPOINT HAS ADDRESS OF INSTRUCTION BEING TIMED
CODES  MOV *R3,R5  FIND WHICH OPCODE IT IS
MOV *R4,R0
AT R6,4
SRL R5,0
SLA R5,0
C R5,*R4+
JEQ CODEHIT
AT R4,6
C *R4,ENDTAB
JNE CODES
LI R1,6
A R1,SPEED
INC ACCESS
B SPOOUT
CODEHIT AT R6,TIMING-4  FIND INFORMATION IN TIMING TABLE
MOV *R6+,R1
SRL R1,8
A R1,SPEED
MOV *R6+,R1
SRL R1,8
A R1,ACCESS
MOV *R6+,R1
JEQ NOSPCMD
SRL R1,8
MOV BRKPNTR,R1
MOV *R3,R5
SRA R5,4
ANDI R5,$3
JEQ NOSCMD    TS=0
DEC R5
JFO TS1
DEC R5
JFO TS2
A C6,SPEED
TS=3
DEC R1
JNE *-6
INCT SPEED
INCT ACCESS

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DECT R5          COUNT WORDS
JNE READMORE
IDLE
MOV INT20AT,R3  R3 = CHECKSUM ON TAPE
SLA R3,8
IDLE
SDC INT20AT,R3
C R3,R4
JEO CHKGOOD
BLWP MESAG
FCC 'CHECKSUM BAD --- RELOAD TAPE'
EVEN
WORD 0
CHKGOOD LI P7,TAPEZ
LI P8,10
CLR R4
ENDTAPE IDLE
C INT20AT,*R7+
JNE NEXTBLCK

DECT R8
JNE ENDTAPE
B START
TAPEZ WORD $FF,$01,$02,$04,$08,$10,$20,$40,$80,$FF
NAM TIMING TABLE
*
*
*
TIMING
BYTE 12          CLOCK LI
BYTE 3
BYTE 1
BYTE 1
BYTE 14          AI CLOCK
BYTE 4          MEM
BYTE 0
BYTE 0
BYTE 14          ANDI
BYTE 4
BYTE 0
BYTE 0
BYTE 14          ORI
BYTE 4
BYTE 0
BYTE 0
BYTE 14          CI
BYTE 3
BYTE 0
BYTE 0
BYTE 8 STWP
BYTE 2
BYTE 0
BYTE 0
BYTE 4 STST
BYTE 2
BYTE 0
BYTE 0
BYTE 10 LWPI
BYTE 2
BYTE 0
BYTE 0
BYTE 16 LIM1
BYTE 3
BYTE 0
BYTE 0
BYTE 12 IOLE
BYTE 1
BYTE 0
BYTE 0
BYTE 0
BYTE 14 RTWP
BYTE 4
BYTE 0
BYTE 0
BYTE 26 BLWP
BYTE 6
BYTE 1
BYTE 0
BYTE 8 B
BYTE 2
BYTE 1
BYTE 0
BYTE 16 CLR
BYTE 3
BYTE 1
BYTE 0
BYTE 0
BYTE 12 NEG
BYTE 3
BYTE 1
BYTE 0
BYTE 10 INV
BYTE 3
BYTE 1
BYTE 2
BYTE 12 INC
BYTE 3
BYTE 1
BYTE 0
BYTE 16 INCT
BYTE 3
BYTE 1
BYTE 0
BYTE 10 DEC
BYTE 3
BYTE 1
BYTE 0
BYTE 10 DECT
BYTE 3
BYTE 1
BYTE 0
BYTE 12 BL
BYTE 3
BYTE 1
BYTE 0
BYTE 10 SPWB
BYTE 3
BYTE 1
BYTE 0
BYTE 10 SETO
BYTE 3
BYTE 1
BYTE 0
BYTE 14 ABS
BYTE 3
BYTE 1
BYTE 0
WORD 3,0          LOS
WORD 0,0          LOC
BYTE 20 SRA
BYTE 4
BYTE 3
BYTE 3
BYTE 20 SRL
BYTE 4
BYTE 3
BYTE 0
BYTE 23 SLA
BYTE 4

```

```

BYTE 3
BYTE 3
BYTE 20 SFC
BYTE 4
BYTE 1
BYTE 0
BYTE 10 JMP
BYTE 1
BYTE 3
BYTE 0
BYTE 10 JLT
BYTE 1
WORD 0
BYTE 10 JLE
BYTE 1
WORD 0
BYTE 10 JEQ
BYTE 1
WORD 0
BYTE 10 JHF
BYTE 1
WORD 0
BYTE 10 JGT
BYTE 1
WORD 0
BYTE 10 JNE
BYTE 1
WORD 0
BYTE 10 JNC
BYTE 1
WORD 0
BYTE 10 JOC
BYTE 1
WORD 0
BYTE 10 JNO
BYTE 1
WORD 0
BYTE 10 JL
BYTE 1
WORD 0
BYTE 10 JH
BYTE 1
WORD 0
BYTE 10 JOP
BYTE 1
WORD 0
BYTE 12 SRO
BYTE 2
WORD 0
BYTE 12 SBZ
BYTE 2
WORD 0
BYTE 12 TA
BYTE 2
WORD 0
BYTE 14 CDC
BYTE 3
BYTE 1
BYTE 0
BYTE 14 CZC
BYTE 1
BYTE 1
BYTE 0
BYTE 14 XOR
BYTE 4
BYTE 1
BYTE 0
BYTE 44 XOP
BYTE 8
BYTE 1
BYTE 0
BYTE 52 LDCR
BYTE 3
BYTE 1
BYTE 0
BYTE 60 STCR
BYTE 4
BYTE 1
BYTE 0
BYTE 52 MPY
BYTE 5
BYTE 1
BYTE 0
BYTE 124
BYTE 6
BYTE 1
BYTE 0
BYTE 14 SZC
BYTE 4
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 - E. ☐ Other
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 - D. ☐ Other

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 - G. ☐ Other
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 - A. ☐ Magazines
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